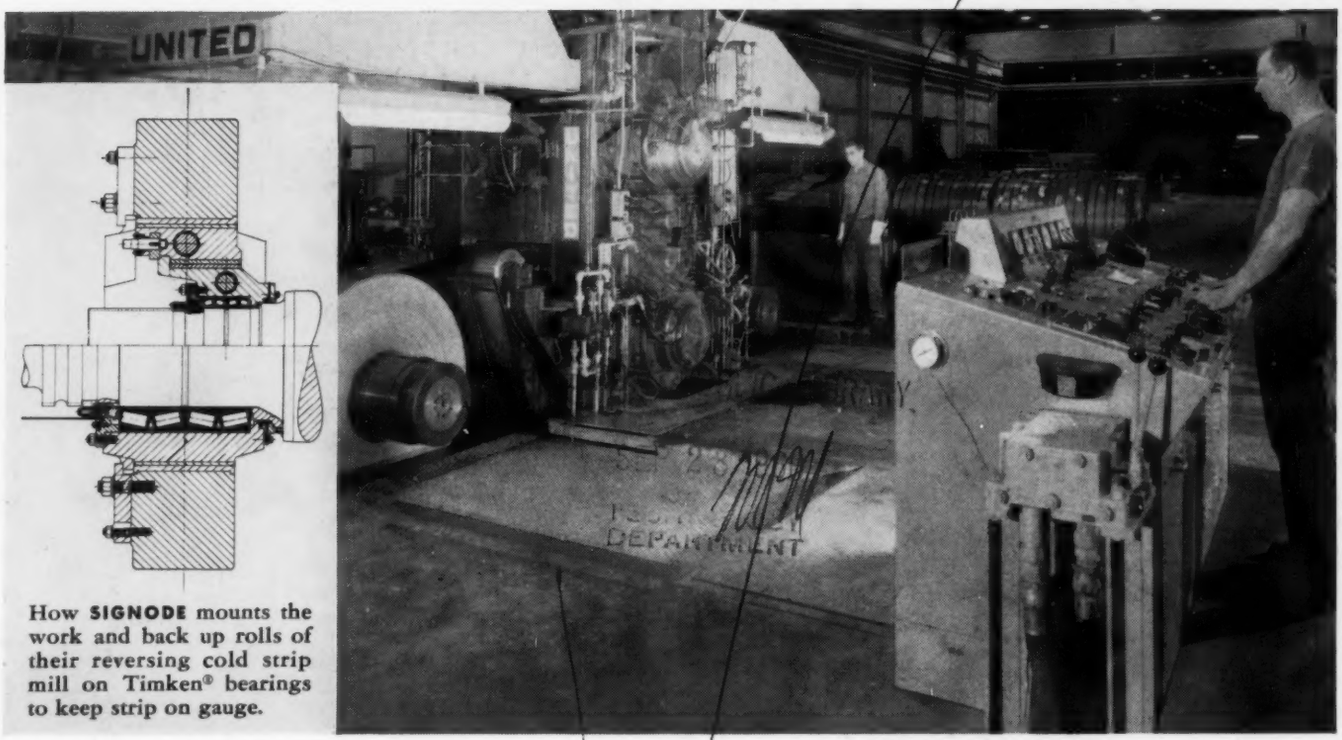
Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

ATTEND THE IRON & STEEL EXPOSITION

SEPTEMBER, 1960



How **SIGNODE** mounts the work and back up rolls of their reversing cold strip mill on Timken® bearings to keep strip on gauge.

Signode's new strip mill controls gauge to .0001″ by X-ray

Timken® bearings keep it on gauge

THIS new 4-high cold strip mill built by United Engineering & Foundry for Signode Steel Strapping Company has a special X-ray gauge that measures and records strip thickness to .0001″. And mounting the work rolls, back up rolls, reel and screw down on Timken® tapered roller bearings helps keep this 11¼″ and 29¼″ by 20″ reversing cold mill turning out strip on gauge—gives Signode maximum economy, assures customers strapping of uniform gauge.

Steel mills the world over use Timken roll neck bearings because they:

1) *Require minimum maintenance.* Timken bearings are tapered and provide the high radial and thrust capacity required by modern steel mill operations.

2) *Give long life.* To make them tough, only the finest bearing-quality alloy steel available is used for Timken bearing rollers and races. In some mills, Timken balanced proportion bearings have rolled over 5,000,000 tons of steel.

Timken bearings practically eliminate friction, cut starting resistance so that scrap losses are held to a minimum. They can be grease or oil mist lubricated. It all adds up to the lowest bearing cost per ton of steel rolled. It's why Timken bearings are on the roll necks of 1051 mills.

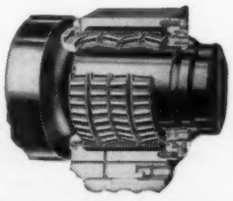
Be sure to get all these advantages when you buy or build a mill. Specify Timken tapered roller bearings.

When you buy Timken bearings you get...

1) Quality you can take for granted.
2) Service you can't get anywhere else.
3) The best-known name in bearings.
4) Pace setter in lower bearing costs.

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Div.: Canadian Timken, St. Thomas, Ont.

See you at the AISE Show, Cleveland Public Auditorium, September 27-30, Booths 134-137.



Industry rolls on

TIMKEN®

tapered roller bearings

Those fellows at

Alliance

certainly know how to Build 'em Big!

Proper research, design, engineering and development are as important as the basic materials that go into building a crane. ALLIANCE knows how to build 'em **big**, and build 'em powerful, and build 'em to last year after year after year.

For the greatest over-all return on your investment, look to Alliance Machine Company. The world's largest builders of the world's largest Cranes.

Greatest over-all return for your investment

"Give Us The Runway and We'll Lift The World"

Overhead Cranes * Gantry Cranes * Mill Cranes and Equipment * Hot Metal Cranes * Ladle Cranes Stripper Cranes * Soaking Pit Cranes * Soaking Pit Cover Cranes * Charging Machines * Furnace Chargers * Slab Handling Cranes * Bucket Cranes Magnet Cranes * Mold Yard Cranes * Skull Cracker Cranes * Ingot Buggies * Run-Out Tables Car Dumpers * Special Mill Equipment * Ore & Coal Bridges * Loading & Unloading Towers Forging Manipulators * Forging Cranes * Power House & Dam Cranes * Dock & Pier Handling Equipment * Research, Development & Engineering Service * Licensees & Manufacturing Facilities in Other Countries

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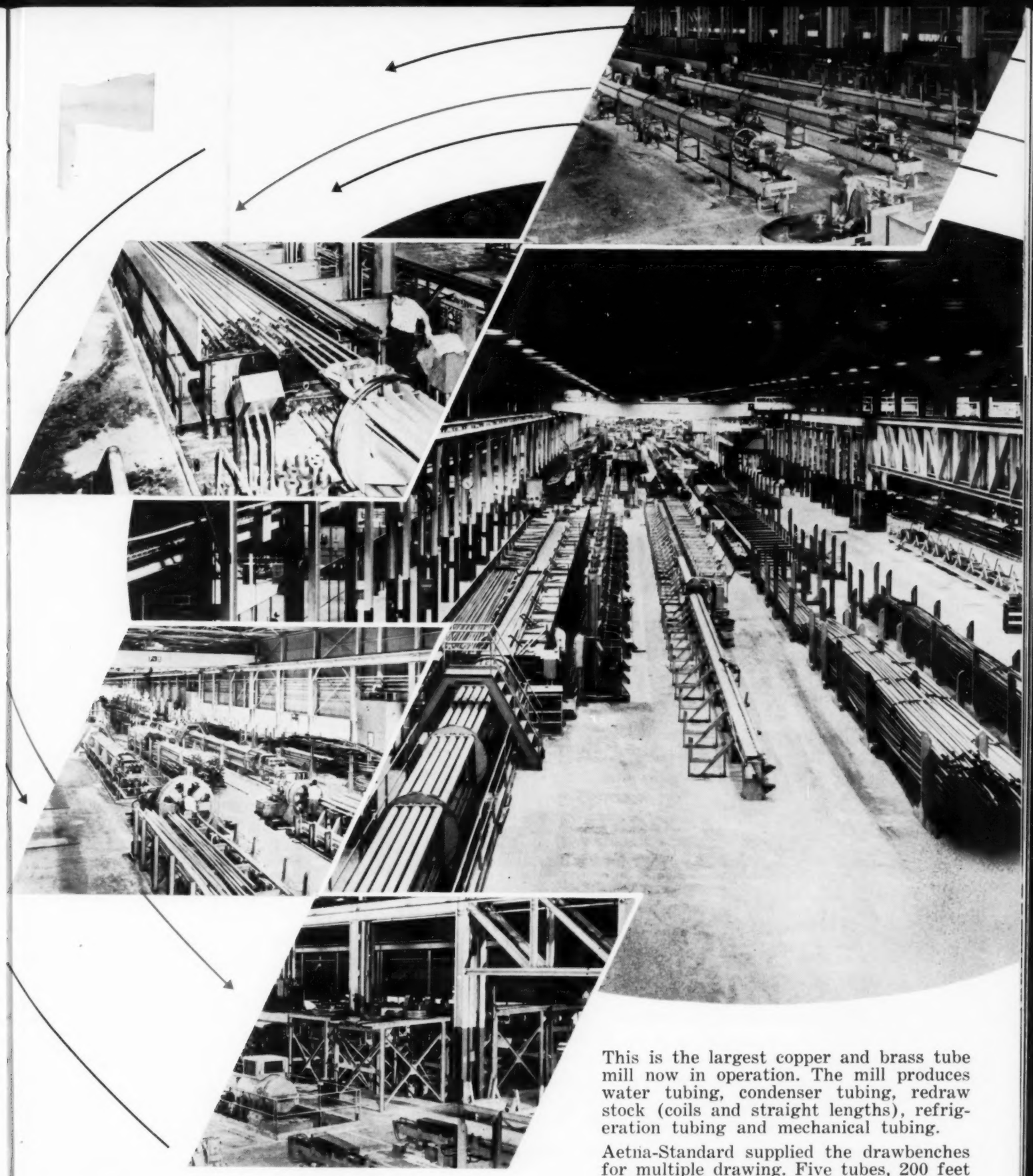


BRASS and COPPER TUBE MILL...

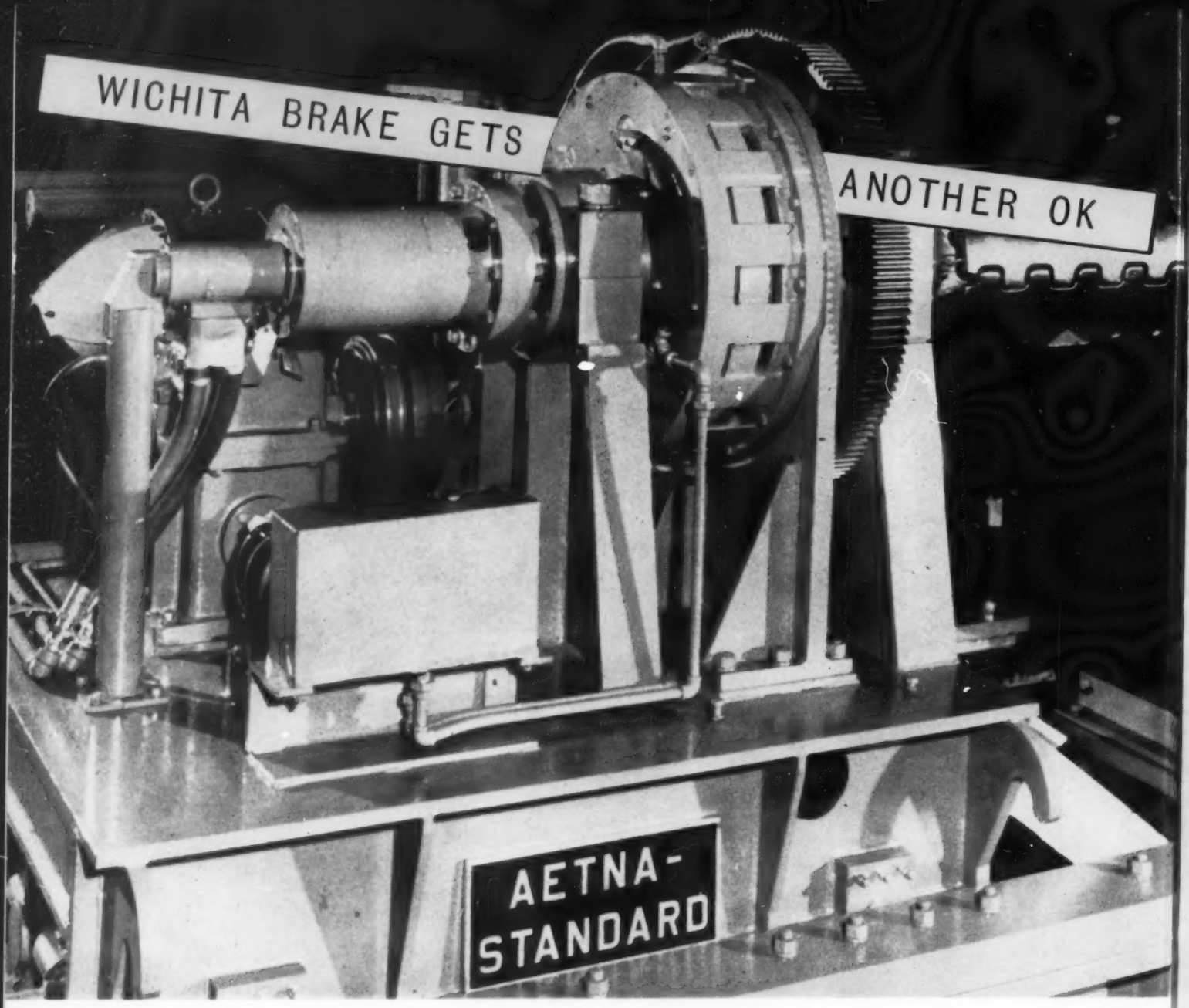
This is the largest copper and brass tube mill now in operation. The mill produces water tubing, condenser tubing, redraw stock (coils and straight lengths), refrigeration tubing and mechanical tubing.

Aetna-Standard supplied the drawbenches for multiple drawing. Five tubes, 200 feet in length, are drawn in a single pass. Aetna-Standard also supplied high speed 60-inch Bull Blocks with turn-style coil handling.

For information on Cold Draw equipment, write to: Aetna-Standard Division
300 Sixth Avenue
Pittsburgh, Pennsylvania

Aetna-Standard Division

BLAW-KNOX



"Most satisfactory brake from a cost and performance basis," says Aetna Standard

The Aetna Standard Pay Off Reel pictured above is equipped with a Wichita Water Cooled Drag Brake . . . selected to perform the work required. Better performance inherent in Wichita designs are helping quality equipment manufacturers like Aetna Standard, solve tough braking or clutching problems.

A Wichita Engineer will be happy to work with your engineering and sales department to help you find the most profitable solution.

Contact your nearest Wichita Engineer!

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Fremont & Lewis, Inc., Cincinnati, Ohio
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Why is this steel coil half air?

To provide an air space between each lamination of the coil! This is the key to a revolutionary new method of controlling the composition of steel, known as the Open Coil Process of Gas Alloying. By "opening" the coil and exposing the entire surface to active gases, many exciting things happen to the composition of steel. To name a few: Low grade Bessemer and open hearth steels can be converted to premium products, rimmed steel can be upgraded by decarburization, renitrogenizing and denitrogenizing practices are greatly simplified. The potential is limitless! Mill executives are calling the Open Coil Process "the greatest advance in steel processing in our generation". We'll have complete data at our Booths 78 and 79 at the AISE Show, or you can get information immediately by writing direct.

Lee Wilson* ENGINEERING COMPANY, INC.

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HIGH PRODUCTION ANNEALING SYSTEMS

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF OPEN COIL AND SINGLE STACK FURNACES

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NEW CONSTRUCTION,
EXPANSION OR ALTERATION? . . .

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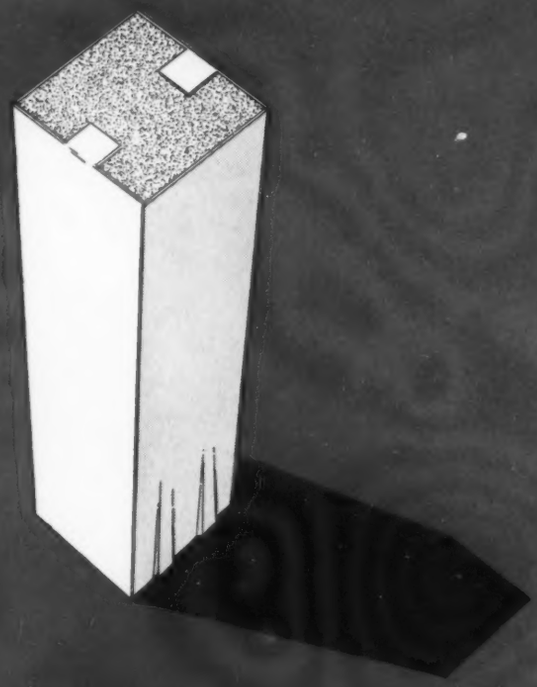
TR 40 MANUFACTURERS OF HOT METAL CARS, CINDER AND SLAG CARS, LADLE TRANSFER CARS, SMELTING & REFINING EQUIPMENT

THIS IS LAVINO'S FERROBOND® CMX 3x3″ ROOF KEY

A NEW BASIC OPEN-HEARTH ROOF BRICK WITHOUT INTERNAL PLATES, DESIGNED BY LAVINO FOR MAXIMUM SERVICE AND ECONOMY



Every split-roof service test, comparing Lavino Ferrobond CMX 3x3″ Roof Keys with internally-plated brick, has shown it to be equal or superior in service life. *In addition, an approximate 8% savings will be realized in material costs whenever a 12″ or thicker roof is installed with Ferrobond CMX 3x3″ Roof Keys.**

*PATENT PENDING

HERE IS THE PERFORMANCE RECORD OF LAVINO FERROBOND CMX 3x3" ROOF KEYS IN SPLIT ROOF TESTS . . . THE MOST ACCURATE AND IMPARTIAL METHOD OF COMPARING BRANDS UNDER IDENTICAL OPERATING CONDITIONS.

The graphs below represent plan views of five open hearth furnace roofs. The blue halves were constructed with Ferrobond CMX 3x3" roof keys, the yellow halves with internally plated 4½x3" basic roof keys. Grey tones indicate where patching was required and the areas in white outline show where the hole developed, terminating the campaign.

SPLIT ROOF TEST "A"
190 ton furnace, 284 heat campaign
construction: 12" ribs 9" valleys
percentage of area patched:

FERROBOND CMX 3x3" ROOF KEYS	1.0%
INTERNALLY PLATED ROOF KEYS	1.6%

SPLIT ROOF TEST "B"
290 ton furnace, 453 heat campaign
construction: 15" ribs, 12" valleys
percentage of area patched:

FERROBOND CMX 3x3" ROOF KEYS	10.4%
INTERNALLY PLATED ROOF KEYS	19.0%

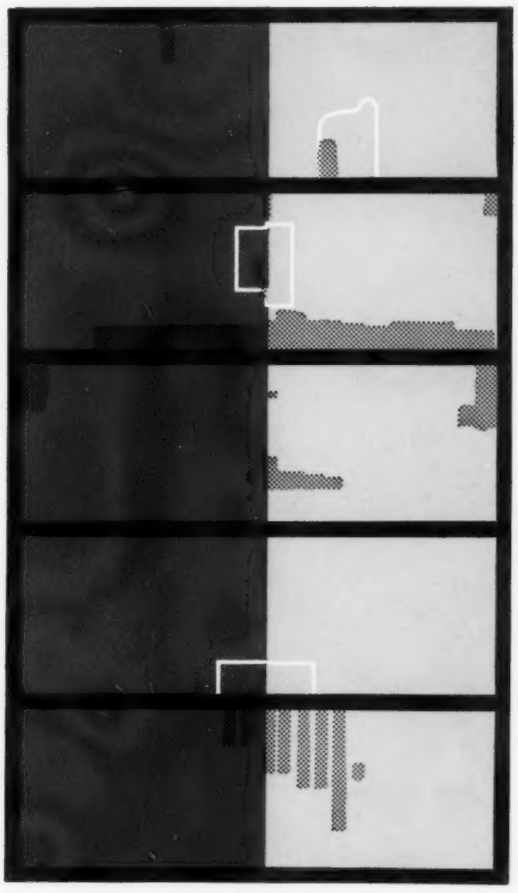
SPLIT ROOF TEST "C"
200 ton furnace, 488 heat campaign
construction: 15" ribs 12" valleys
percentage of area patched:

FERROBOND CMX 3x3" ROOF KEYS	2.8%
INTERNALLY PLATED ROOF KEYS	6.6%

SPLIT ROOF TEST "D"
400 ton furnace, 298 heat campaign
construction: 15" ribs 12" valleys
NO PATCHING

SPLIT ROOF TEST "E"
190 ton furnace, 250 heat campaign
construction: 12" ribs 9" valleys
percentage of area patched:

FERROBOND CMX 3x3" ROOF KEYS	2.2%
INTERNALLY PLATED ROOF KEYS	12.6%



In every split roof installation of Ferrobond CMX 3x3" roof keys, they have been compared with internally plated brands of other manufacturers . . . in each case they have proven equal or superior to these brands from a service standpoint . . . coupled with their economy and ease of installation, Ferrobond CMX 3x3" roof keys emerge as today's outstanding value in basic roof brick.

E. J. LAVINO
and company

REFRACTORIES DIVISION SALES OFFICES:
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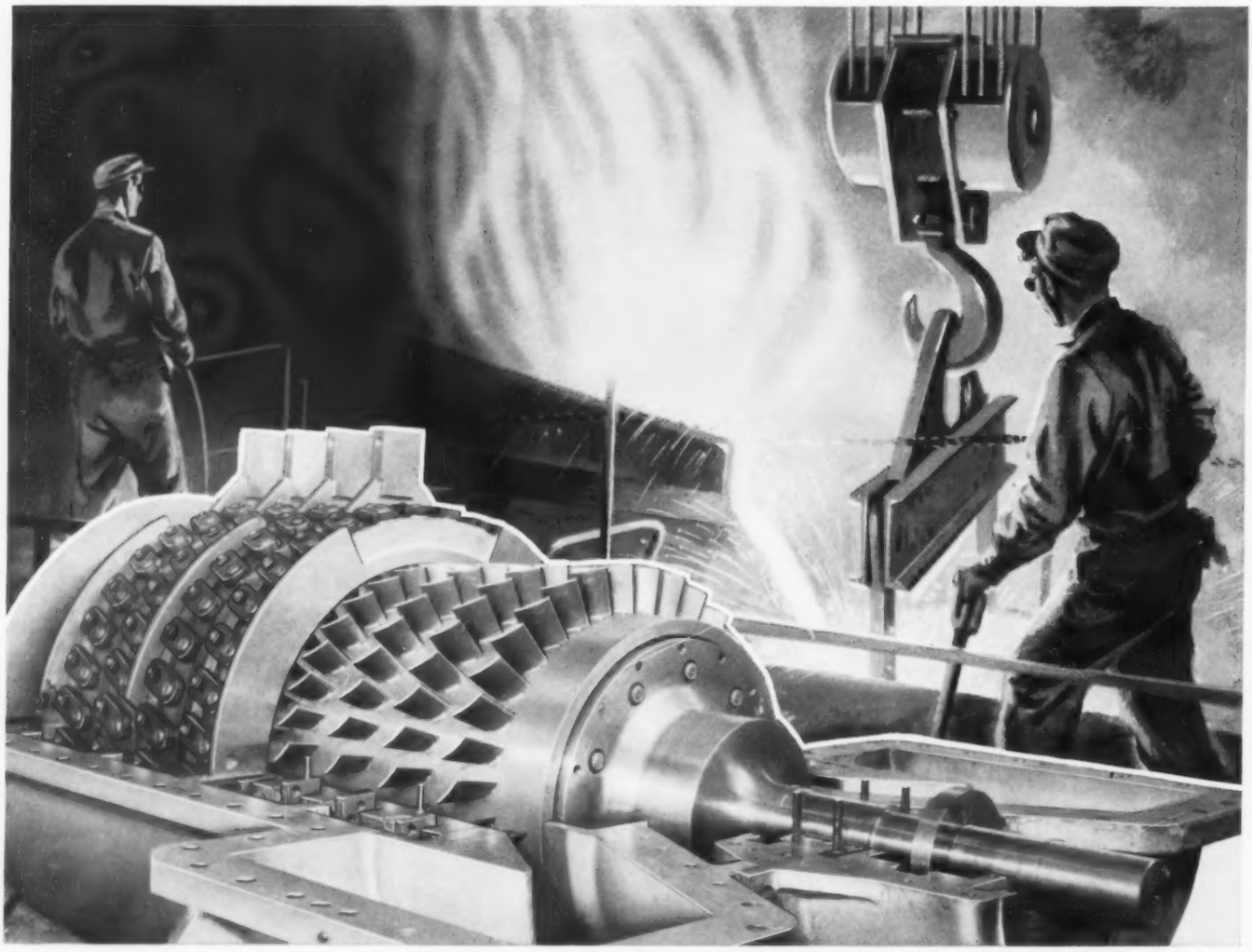
Your company is being contacted by Lavino representatives with details of our basic roof proposals.

ALLIS-CHALMERS

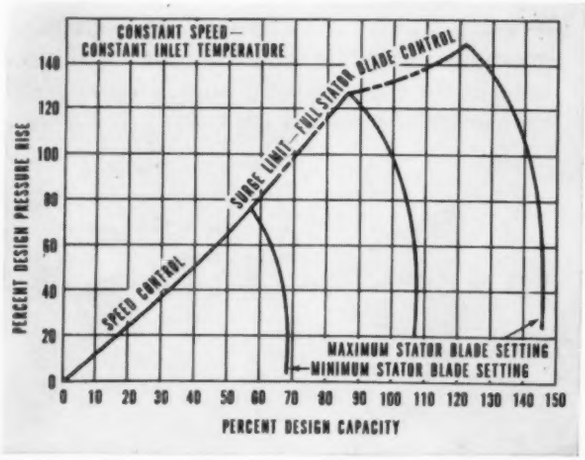


U. S. Steel Orders World's First

Adjustable Blade Axial Compressor for Blast Furnace Duty

Scheduled for 1961 installation at the Edgar Thomson Works, this 165,000 cfm, 50 psig. axial compressor is designed to provide wide operating range, lower steam requirements and save space. Fully adjustable stator blades will allow U. S. Steel to vary capacity while the machine is operating, to meet a broad range of operating conditions. Characteristics inherent in axial design will provide them with relatively constant volume when increased pressure is required, and will reduce steam requirements by 10% or more. But that's not all — U. S. Steel will receive additional savings in handling, foundation and space costs because this axial compressor will be *half* the diameter and *half* the weight of an equivalent centrifugal compressor.

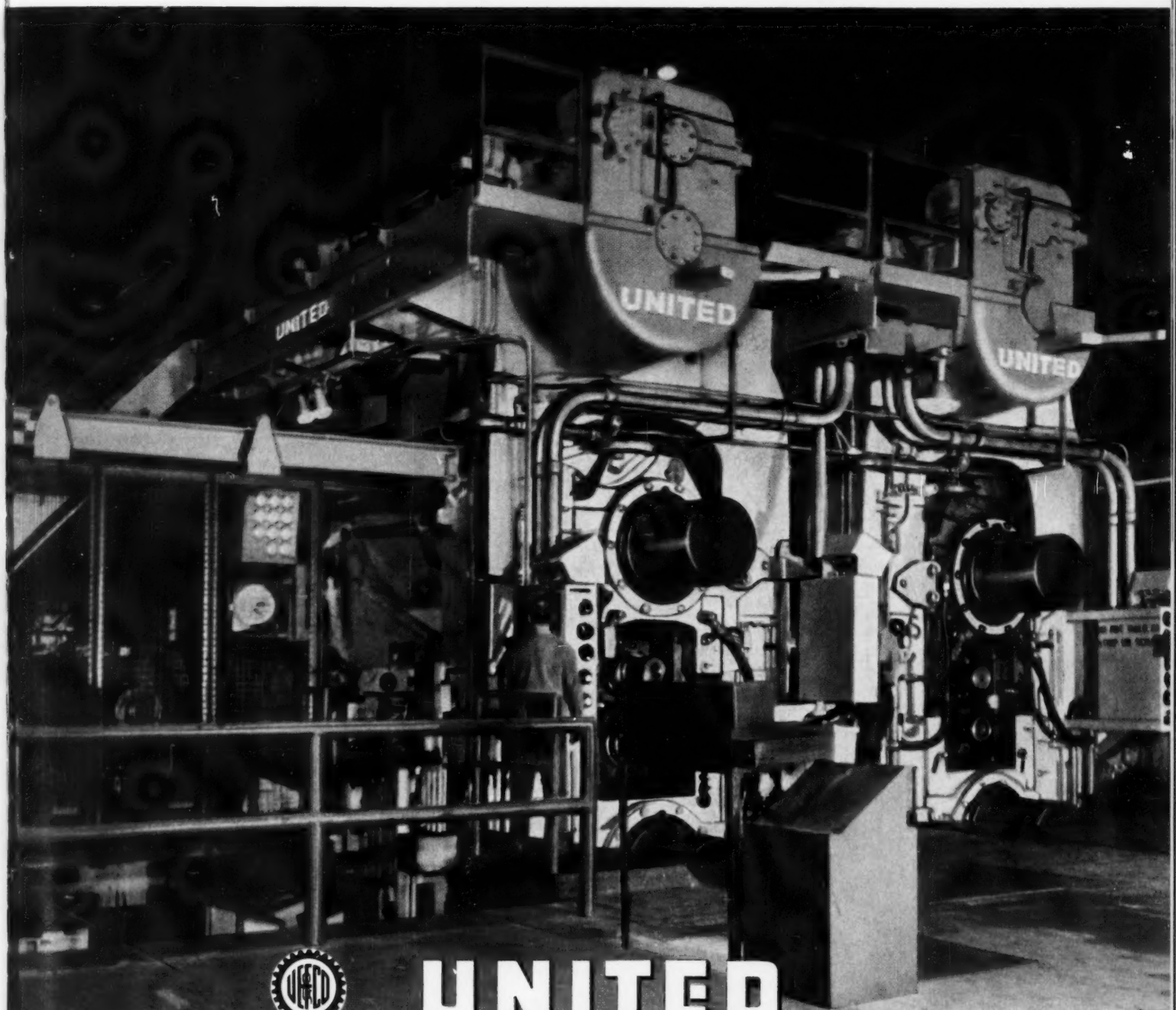
Let us analyze your blast furnace requirements and show you how axial compressors can be used to advantage in your operations. Write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1374



See a working adjustable stator blade model at the A-C exhibit Iron and Steel Exposition — September 27-30, 1960

UNITED®

4-HIGH 2-STAND TANDEM TEMPER PASS MILL



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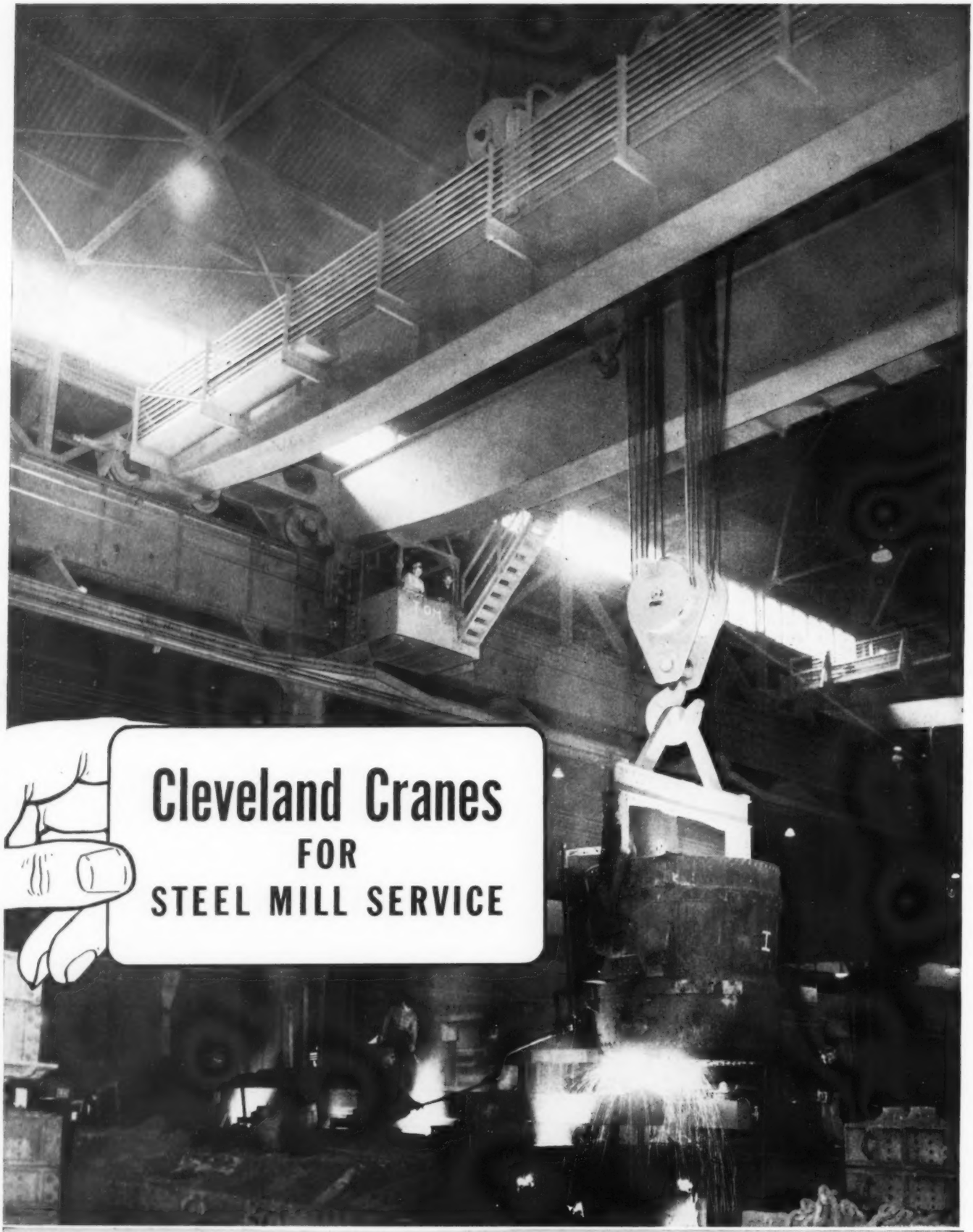
Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio
Stedman Foundry and Machine Co., Inc., Aurora, Indiana

Designer and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.



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MODERN ALL-WELDED STEEL MILL CRANES

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WICKLIFFE,
OHIO

Crops *and* Shorts

△ In efforts to combat competition from nonferrous materials and from foreign steel, American steel producers are emphasizing research on new steels and new uses for steel. Such research is good, but equally important is the search for and application of cost-cutting production and maintenance ideas. A prime source of such ideas is the Iron and Steel Exposition to be held in Cleveland, Ohio, September 27, 28, 29, 30. Here leading suppliers of equipment, supplies and services to the iron and steel industry will unveil a host of new developments. In addition, 15 technical sessions at the AISE Annual Convention will tell how steel producers can improve practices and economy. Anyone interested in such matters will find ideas for the taking. Plan to attend—and send your men, too.

△ Suppliers to the steel industry might be of considerable help in the competitive struggle mentioned above. Instead of advertising designed merely to build a corporate image, greater use might be made of so-called product advertising. Case histories of savings made by the application of a manufacturer's product might help—advertisements that say "Here's what we did for someone," rather than "See what a great outfit we are." The men in the plants who specify and buy have often indicated their preference for this.

△ A disillusioned father says that, if a growing object is both fresh and spoiled, chances are it is a child.

△ Browsing through some statistics, we were reminded that the average steel wage went from $1.80 in 1949 to $3.66 in 1959, slightly more than double. Neither figure includes the cost of social security, pensions or insurance. Looking a bit further, we noted that in 1959, 1,003,258,691 man-hours were worked to produce and finish 93,446,132 net tons of ingots, whereas 1949 showed 1,073,204,921 man-hours for 77,978,176 tons. Thus, we have 10.8 man-hours per ton in 1959 and 13.75 in 1949. In 10 years, productivity increased 21.4 per cent, wages 102 per cent.

△ Someone claims that three out of five Americans have checking accounts, and last year wrote almost 10,000,000,000 checks worth more than $3,000,000,000,000.

△ The steel industry's safety record improved materially through the decade of the 50's. Accident frequency dropped from 5.28 to 3.51 lost time injuries per million man-hours worked, down 33 per cent. The severity rate decreased from 1190 to 915 days lost per million man-hours worked, a drop of 23 per cent.

△ From now until November 8, our ears and eyes will be bombarded with political propaganda. Everyone will be promised something, with no mention of price tags. Of course, we might try ear plugs and blinders.

Commenting on our election, the London Sunday Dispatch says, "Whichever presidential candidate is elected, Mr. Macmillan will soon be doing business with a much tougher president than his old friend Ike."

△ Shipments of finished steel products from the mills for the first half of 1960 totaled 42,853,937 net tons. Cold rolled sheets continue to be the leading product with 20.3 per cent of the total. Then come hot rolled sheets, 11. 5 per cent; hot rolled bars, 10.1 per cent; and plates, 9.0 per cent. The automotive industry remains the best customer, using 20.8 per cent of the total.

△ Glasses don't always help vision, particularly after they've been emptied a few times.

△ Foreign iron ore continues to make up an increasing portion of ore used in the United States. Figures released by the American Iron Ore Association indicate that foreign ore (excluding Canadian) accounted for 13,709,224 gross tons, or 25.5 per cent of steel plant receipts during the first half of 1960. Corresponding figures for 1959 were 10,562,474 tons or 21.3 per cent.

△ Railroads receive about eight cents for moving a ton of mail one mile, as compared with approximately 39 cents paid the airlines by the Post Office Department.

△ According to the American Iron and Steel Institute, steel and iron accounted for 95 per cent of the metals produced in the United States during the past ten years. The combined production of ferrous and nonferrous metals averaged over 113,500,000 net tons per year. Of this, raw steel averaged 101,900,000 tons, merchant pig iron 5,500,000 tons. Copper, aluminum, zinc, lead and magnesium averaged about 6,100,000 tons.

△ F. A. McClelland, vice president of sales for Wheeling Steel Corporation, believes his company's customers have reduced their inventories to the point where new supplies of steel will be ordered. He looks for substantial orders from the automobile industry and improvement in construction.

"One factor on the dark side," Mr. McClelland said, "is the continuing high rate of imports of foreign steel pipe. From January to June, more than 250,000 tons of pipe and tubing, valued at about $42,000,000, were shipped into this country by producers in Australia, Canada, England, Germany, Japan, etc."

△ The William Feather Magazine tells about a man who ordered five martinis set up in a row, drank the second, third and fourth, and left the others for the drain. Why? Because he disliked the taste of a first martini and because his wife always smelled the last one.

MOVIE: "STOP LOSS WITH ORGANIZED LUBRICATION," a new 20-minute color-and-sound film created to show the opportunities for cost control through Organized Lubrication.

EDUCATIONAL FILM PACKAGE for plant departments consists of movies on greases, hydraulic oils, cutting oils, etc., that may be selected after seeing the "Stop Loss" film.

HERE ARE THE TOOLS THAT CAN HELP YOU

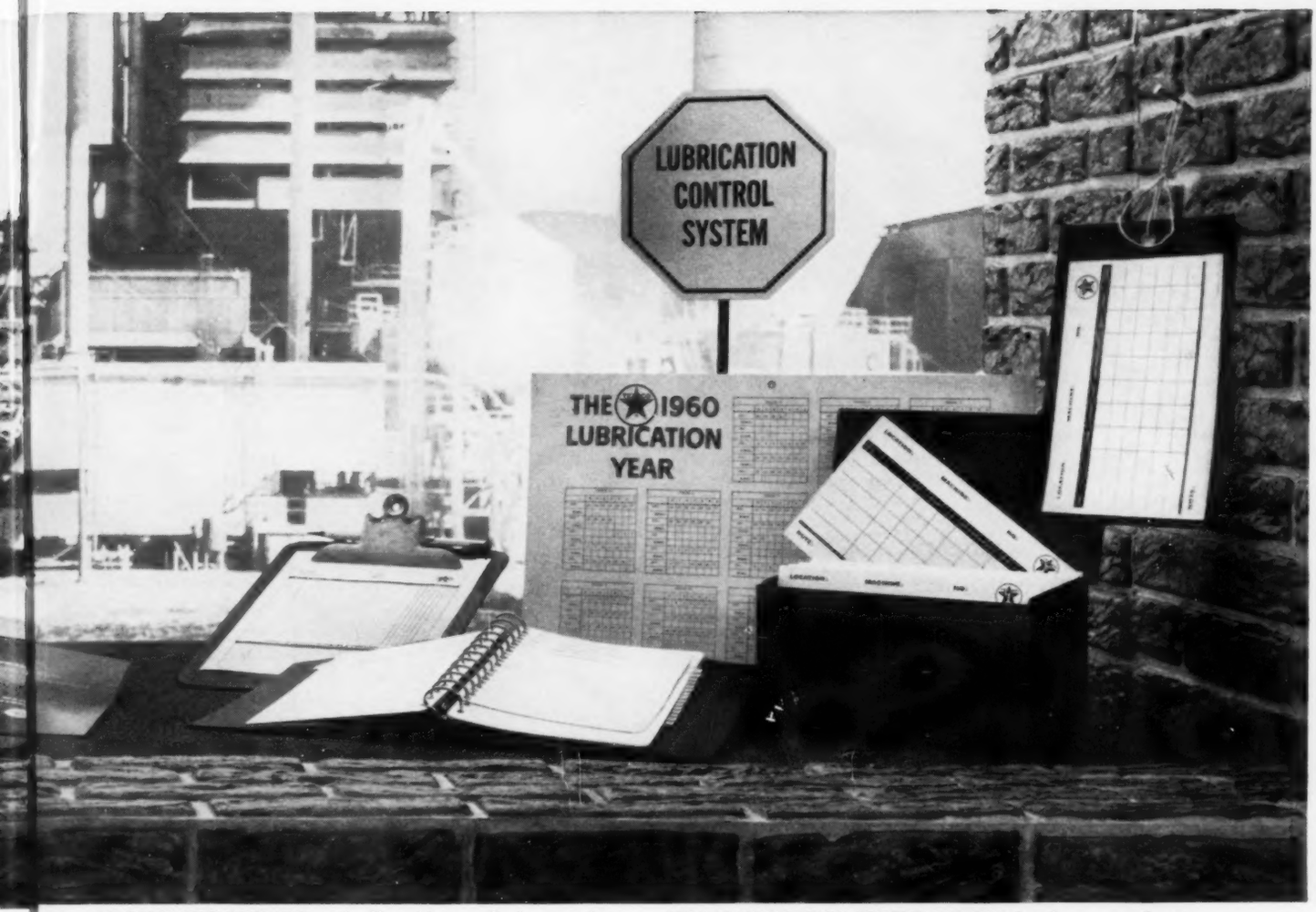
INCREASE YOUR NET PROFITS

Texaco's new "Stop Loss" program is designed to cut maintenance costs by modernizing lubrication practices. If yours is an average plant, the results can add 4 per cent to your net profit.

Even if your plant is an efficient operation, it is still virtually certain that there is an opportunity for cost control you are overlooking—either partially or completely. Here's what the Small Business Administration says in a recent publication:

Suppose there is an average plant, which sells $1,000,000 worth of goods per year. The net profit of this average company would be $73,400 and the maintenance cost would be $29,900. Now, suppose that by *better lubrication*, maintenance costs are reduced 10%, or $2990, *the $2990 will go directly into profit*—an increase of 4%.

A Texaco "Stop Loss" Program is designed for you. Texaco has developed a program specifically designed to help cut your maintenance costs via better lubrication practices. It will help you increase machine life, minimize downtime, reduce lube inventory, even cut purchasing costs. And the savings you make go directly into profits.



CO-ORDINATED BOOKLETS on the film subjects and others can be used as guides in specific areas.

TEXACO LUBRICATION CONTROL SYSTEM takes the guesswork out of your lubrication scheduling. It costs almost nothing to install, yet can add thousands of dollars a year to profits.

BY AS MUCH AS 4 PER CENT!

Can your plant pass this test? If the answer is "no" to any of the following questions, it is almost certain that a Texaco "Stop Loss" Program can improve your profit picture.

1. Is there a central source of responsibility in your plant for *all* lubrication? Yes ☐ No ☐
2. Can your machine operators devote all their time to production without worrying about lubrication? Yes ☐ No ☐
3. Is there any system for making sure that equipment gets lubricated in the right spots at the right time? Yes ☐ No ☐
4. Have you had a lubrication study made to eliminate costly duplication of lubricants? Yes ☐ No ☐
5. Are your oilers qualified men with knowledge of mechanisms lubricated? Yes ☐ No ☐

See for yourself how "Stop Loss" works! Texaco has just released a new color-and-sound movie to dramatize the benefits of good lubrication practices. It's called "Stop Loss through Organized Lubrication" and we think it would be valuable to you to see it. For a showing in your plant soon, mail in the coupon today!

Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

MAKE YOUR RESERVATION TODAY!

TEXACO INC., Dept. IS-160
135 East 42nd Street
New York 17, New York

I would like to see "Stop Loss through Organized Lubrication." Please call to arrange a showing in my plant.

Name_____ Title_____

Firm_____

Address_____

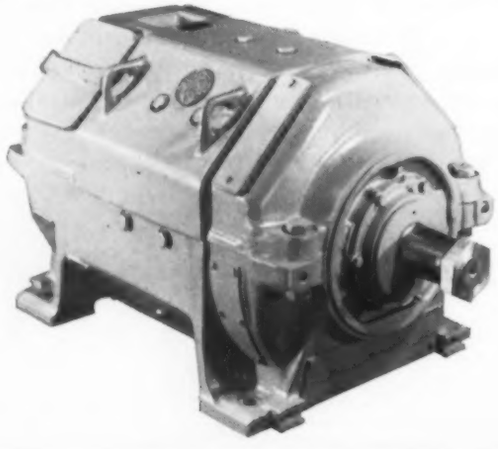
City_____ Zone____ State_____

TEXACO

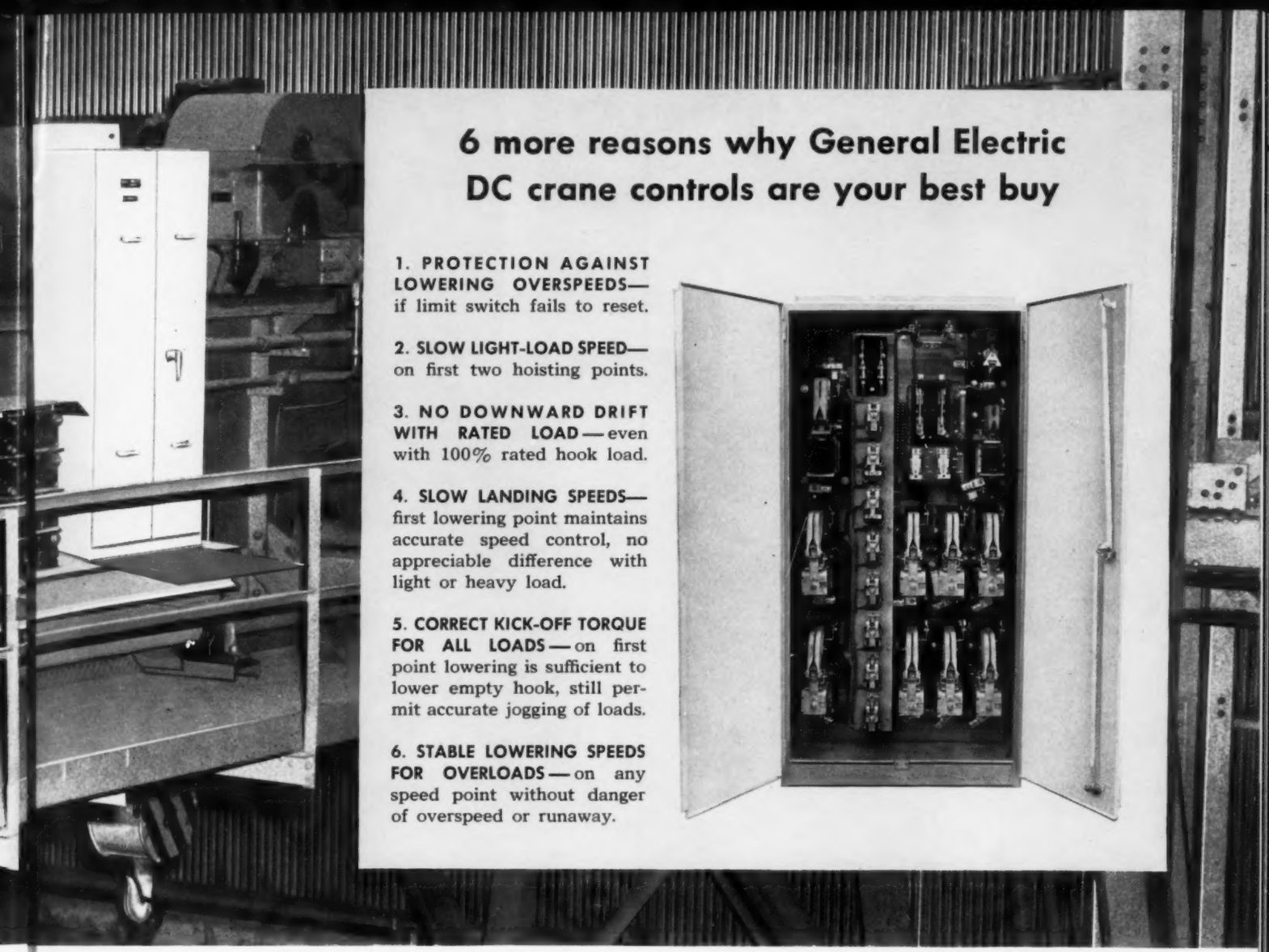
WITH G-E FRONT-CONNECTED DC CRANE CONTROL

Eliminate need for back aisles, reduce

MD-600 MOTORS . . . the sturdiest, most versatile mill motors on the market



The General Electric MD-600 totally-enclosed armored motor is built for the heavy-duty handling requirements of steel mills. When used in combination with General Electric d-c crane control, you get outstanding performance, minimized maintenance, and your crane-drive lasts longer. The MD-600 motor accelerates heavy loads quickly, handles heavier long-time overloads, and withstands frequent heavy-duty cycles. Maintenance is simplified by the split frame which swings open almost 180 degrees to allow the armature to be lifted straight out. The MD-600's heavy cast-steel frame is sturdy—it's designed to withstand the most severe shock. Since its introduction in 1947, the MD-600 motor has earned its reputation as the sturdiest, most versatile mill motor available.



6 more reasons why General Electric DC crane controls are your best buy

1. PROTECTION AGAINST LOWERING OVERSPEEDS—if limit switch fails to reset.

2. SLOW LIGHT-LOAD SPEED—on first two hoisting points.

3. NO DOWNWARD DRIFT WITH RATED LOAD—even with 100% rated hook load.

4. SLOW LANDING SPEEDS—first lowering point maintains accurate speed control, no appreciable difference with light or heavy load.

5. CORRECT KICK-OFF TORQUE FOR ALL LOADS—on first point lowering is sufficient to lower empty hook, still permit accurate jogging of loads.

6. STABLE LOWERING SPEEDS FOR OVERLOADS—on any speed point without danger of overspeed or runaway.

floor-space requirements 50 percent

General Electric front-connected d-c crane control —introduced in 1957—makes back aisles unnecessary . . . cuts floor space needs by one-half. The modern design—in a smaller cabinet—allows installation on a smaller bridge, permitting closer hook approach to the ends of your building. The control is safer, lasts longer, and needs only minimum maintenance.

General Electric d-c crane control is performing dependably on many heavy-duty jobs—ladle cranes, soaking pits, skullcrackers, and scrap and slab yards. Over 125 hoist controls utilizing this front-connected design are installed and operating reliably.

Check these important benefits of General Electric d-c crane control for the steel industry.

Less maintenance—Definite time acceleration and deceleration provide excellent commutation and motor operation of d-c cranes . . . reduce maintenance.

Greater personnel safety—All devices are serviced from the front . . . no need to work behind panel.

Fewer spare parts—D-c crane controls and mill-drive controls use same devices . . . fewer spares needed.

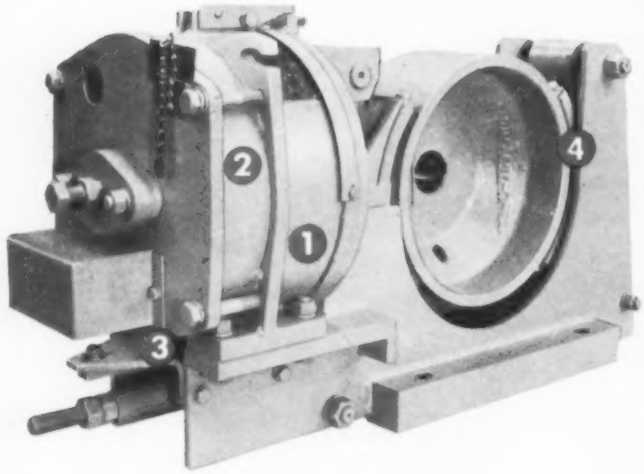
Longer equipment life—Heavy-duty unit bases and picture-frame construction provide long service.

For complete information on General Electric d-c crane control **and** MD-600 crane-drive motors, contact your nearest G-E Apparatus Sales Office or write Sect. 785-12, General Electric Co., Schenectady, N. Y.
Industry Control Dept., Salem, Virginia
Direct Current Motor and Generator Dept., Erie, Pa.

Progress Is Our Most Important Product

GENERAL ELECTRIC

MILL-DUTY ACCESSORIES



DC BRAKES

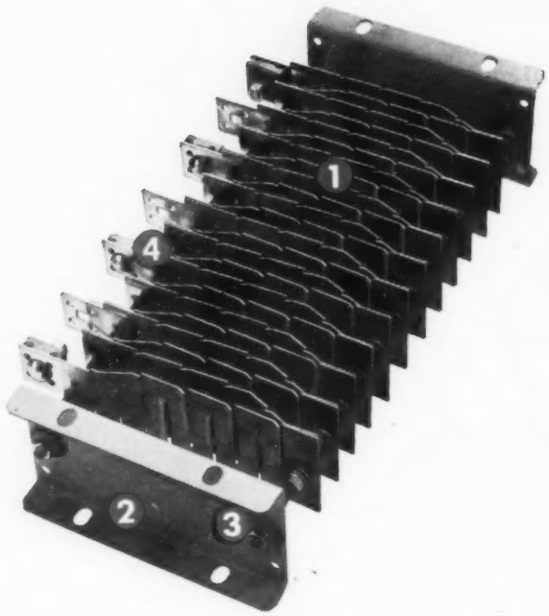
Single-end adjustment speeds maintenance and installation

New General Electric d-c brakes — featuring single-end shoe adjustment — are designed for easy maintenance and versatile installation. And, compensation for lining wear requires simple adjustment from only one end of the brake!

Here are more new features which make General Electric d-c magnet brakes your best buy for dependable, low-maintenance service:

1. **New magnet housing design** permits vertical removal, easy interchange.
2. **New coil** features all high temp. insulating materials potted in epoxy making brake ideal for the most rugged jobs.
3. **New pivot arm** assures equal shoe braking pressure.
4. **Easy lining replacement** does not require removal of brake shoe assembly . . . just lining.

Want details? See your G-E Apparatus Sales Engineer. Or, write Sect. 784-27, General Electric Co., Schenectady, N. Y., for Bulletin GEA-7067. *Industry Control Dept., Salem, Virginia.*



PUNCHED GRID RESISTORS

Designed for fast, low-cost installation

A combination of unique features makes corrosion-resistant, non-breakable, and all-welded General Electric punched-steel grid resistors easier, faster, and less costly to install. Key features are:

1. **Unique grid paralleling** saves time and expense since all parallel connections are made at factory. Grids come either series or parallel.
2. **Draw-out construction** speeds mounting in frame, assures positive alignment. Boxes are readily removed without disturbing those in place.
3. **Clip-lock and carriage-bolt fastener**— special device on runner guides locks box securely in frame. Front is bolted with only 2 self-holding bolts.
4. **All-purpose terminals** accommodate bus or cables. Taps provide means for adjusting resistance values.

Like to know more? Contact your G-E Apparatus Sales Engineer, or write Sect. 784-27, General Electric Co., Schenectady, N. Y., for GEA-6858. *Industry Control Dept., Salem, Va.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Typical Hauserman interior wall installation.

The E. F. HAUSERMAN COMPANY Gets Dead Flat Sheet Steel with VOSS Roller Levelers

...and saves time and money doing it!

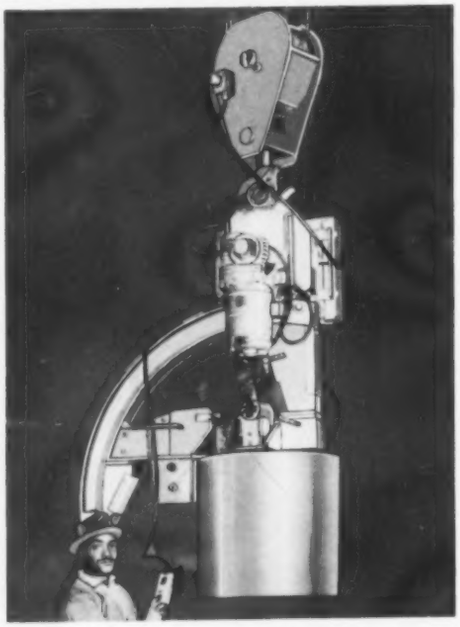
Hauserman standards are *tough*. Every sheet of steel used in a Hauserman movable interior wall is inspected on a slate table for absolute flatness. Before Voss levelers were installed, the company used stretcher-leveled sheets ... and still had to reject 33% as not meeting their severe specifications. Now steel is ordered in coils, and Voss-leveled on their own processing line. Rejects are consistently held under 5%, and the company gains the economy and flexibility of handling steel in coil form. Voss levelers have operated at Hauserman for 10 trouble-free years. They help the company maintain the most rigid quality standards in the movable partition industry.

Voss levelers are currently at work in plants of many primary steel and aluminum producers and major fabricators. Applications include high speed galvanizing lines, hot and cold rolled shear lines, steel plate, aluminum sheets and coils, and others. Let Voss put its experience to work on your leveling problems.

Voss ENGINEERING CO.

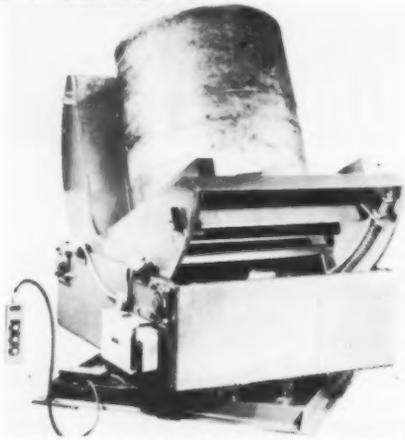
7301 Penn Ave. Pittsburgh 8, Pa. Churchill 2-4422

MANSAVER®
Motor-Driven Coil Turnover Grab



Turn coils from the horizontal to the vertical and reverse smoothly. Grab is inserted into coil in either position. Motor applies initial pressure. As the coil is lifted and rotated an additional mechanical grip is applied. Used to take coils directly from storage and to deliver them at point of use in correct position.

Floor Mounted MANSAVER® Coil Positioner



Upends and rotates coils 180° simultaneously so that they can be removed at same position as they are loaded. This feature is of value chiefly in the storeroom to speed fork truck handling. Can be supplied to rotate coils only or to rotate and revolve as separate motions.

Ask our District Representative into your plant to study your problem for presentation for our solution.

SEE Operating Model of Turnover Grab AT THE SHOW — Booth No. 9.

MANSAVER INDUSTRIES, Inc.

3116 East St.,
New Haven, Conn.

Also Manufactured in England by George W. King Co. and in France by Ets. Dujardin et Cie.

SPRAYING SYSTEMS CO.

DESCALING NOZZLES

in hardened stainless steel

in stainless steel with tungsten carbide orifice tips

*** compact**
modern design . . . only ½ to ⅓ the size of old nozzle types

*** advanced hydraulic design**
gives extremely sharp, hard hitting FLAT SPRAY pattern

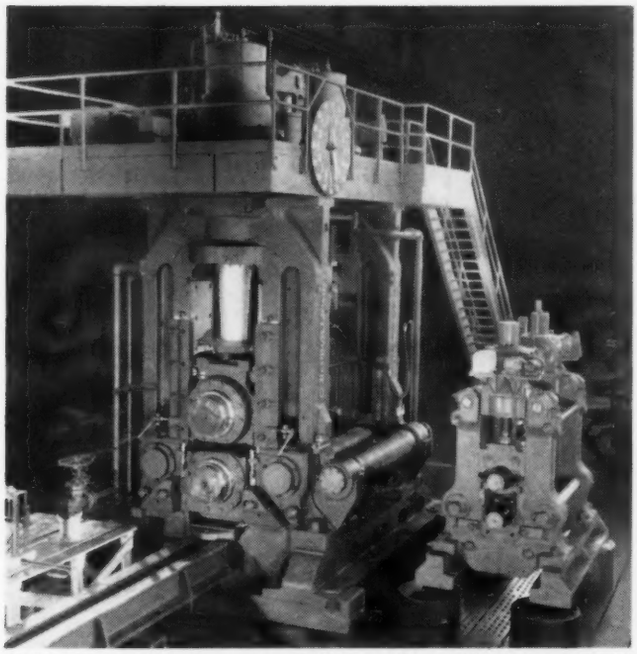
*** large open orifice**
keeps clogging to a minimum

Here are spray nozzles with sharp, high-impact flat spray patterns to materially improve your descaling operations. They're small in size for easier installation and better performance. The unusually large orifices go far in solving clogging problems. Made in all capacities in hardened stainless steel for high resistance to sand and silt. And for maximum possible abrasion resistance, they're also made with Tungsten Carbide orifice inserts. Just write . . . we'll be happy to send you complete Descaling Spray Nozzle information.

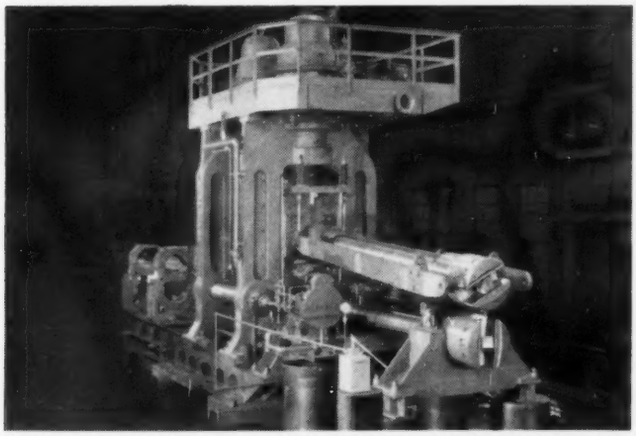
HEAVY DUTY LINE STRAINERS

Spraying Systems now offers line strainers in a full range of sizes . . . with threaded connections up to 4″ N.P.T. size . . . and flanged connections in 3″, 4″ and 6″ pipe size. Designed for operation at pressures up to 125 psi. Unusually large screen areas for high volume capacity. Heavy duty, reinforced screens. Easily flush-cleaned through bottom plug or drain cock. Write for Bulletin 94.

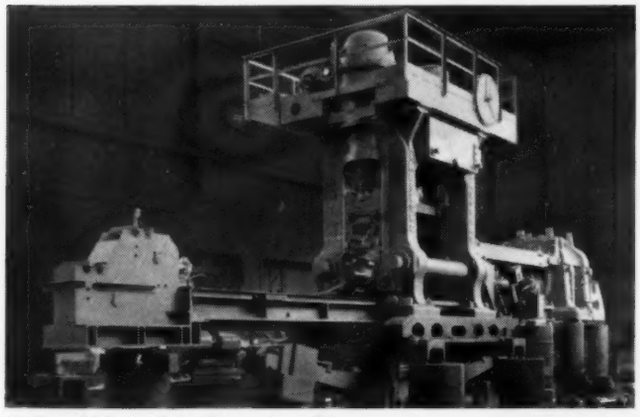
SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS



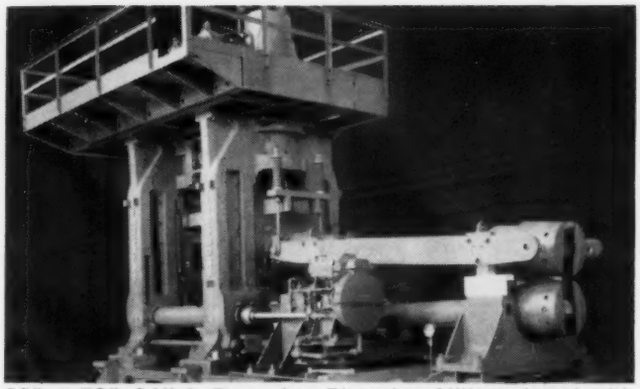
36″ x 78″ 2-High Reversing Billet and Slab Mill equipped with anti-friction bearings, hydraulic roll balance and a single roll changing rig. An 18″ Billet and Slab Mill is shown for comparison. This mill has water lubricated bearings and tilting cap housings.



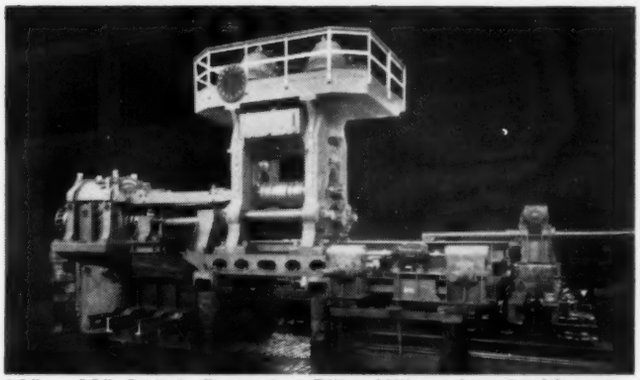
28″ x 70″ 2-High Reversing Blooming Mill equipped with water lubricated bearings, counterweight roll balance, feed rolls and a duplex roll changing rig.



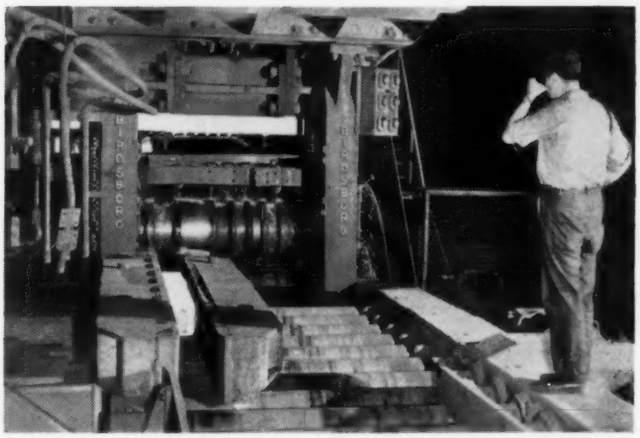
22″ x 66″ 2-High Reversing Blooming Mill equipped with water lubricated bearings, counterweight roll balance, feed rolls, and a crane operated single roll changing rig.



32″ x 78″ 2-High Reversing Blooming Mill equipped with water lubricated bearings, counterweight roll balance, feed rolls, and a duplex roll changing rig.



26″ x 66″ 2-High Reversing Billet Mill equipped with water lubricated bearings, counterweight roll balance, feed rolls, and a duplex roll changing rig.



20″ x 60″ 2-High Reversing Billet Mill shown in operation. This mill has water lubricated bearings, counterweight roll balance, and a duplex roll changing rig.

Blooming, Slabbing, Billet and Roughing Mills

designed and built by

MM 89-60

BIRDSBORO
CORPORATION

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS
ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL • **BIRDSBORO, PENNSYLVANIA**

DAVY-UNITED

AUTOMATIC GAUGE CONTROL

OPERATING IN CANADA

56-inch 4-High Cold Reversing Mill at Dominion Foundries and Steel Limited, Hamilton, Ontario, which is equipped with the Davy-United system of Automatic Gauge Control. This mill rolls steel strip for tin plate between 24 inches and 50 inches wide in a range of thicknesses from .006 inches to .050 inches.

Six Automatic Gauge Control installations have now been completed or ordered in North America and Licensees in North America for the Davy-United system of Automatic Gauge Control include General Electric Company of the U.S.A., Canadian General Electric Company Limited and Canadian Westinghouse Limited.

AGC by DAVY-UNITED

DAVY AND UNITED INSTRUMENTS LIMITED, DARNALL WORKS, SHEFFIELD, ENGLAND

379/DV

View of One Bay in the New Research Building
Showing the Continuous Strip and Bell Furnaces.

THE ELECTRIC **EF** FURNACE CO.

GAS • OIL • ELECTRIC

completely equipped

Research Department

to develop and test improved heat treating techniques benefitting ALL metal producers and fabricators . . .

From the company's earliest beginning research has been traditional at The Electric Furnace Co.

Recently our facilities have been much enlarged. Our research department now has its own building, 180 feet long by 80 feet wide. Equipment includes a continuous strip furnace suited for processing at various cycles; bell, wire mesh belt, batch and pusher furnaces, with and without forced circulation; vacuum furnaces for batch or continuous operation; endothermic and exothermic generators; ammonia dissociators; atmosphere refrigerators; adsorption type gas dryers; CO_2 scrubbers, and completely equipped chemical and metallurgical laboratories.

From these larger facilities are coming improved techniques for treating the familiar materials, and new techniques for treating the newer metals of the jet and space age;— also expanded testing of critical materials used in our furnaces, to maintain our unsurpassed standards of quality and performance.

As in the past, our research facilities will be available to **all** metal producers and processors, for development and test work, conducted, if desired, in the presence, and with the assistance of your own technical men.

This complete and modern laboratory is as close to you as your telephone. Feel free to use it frequently!

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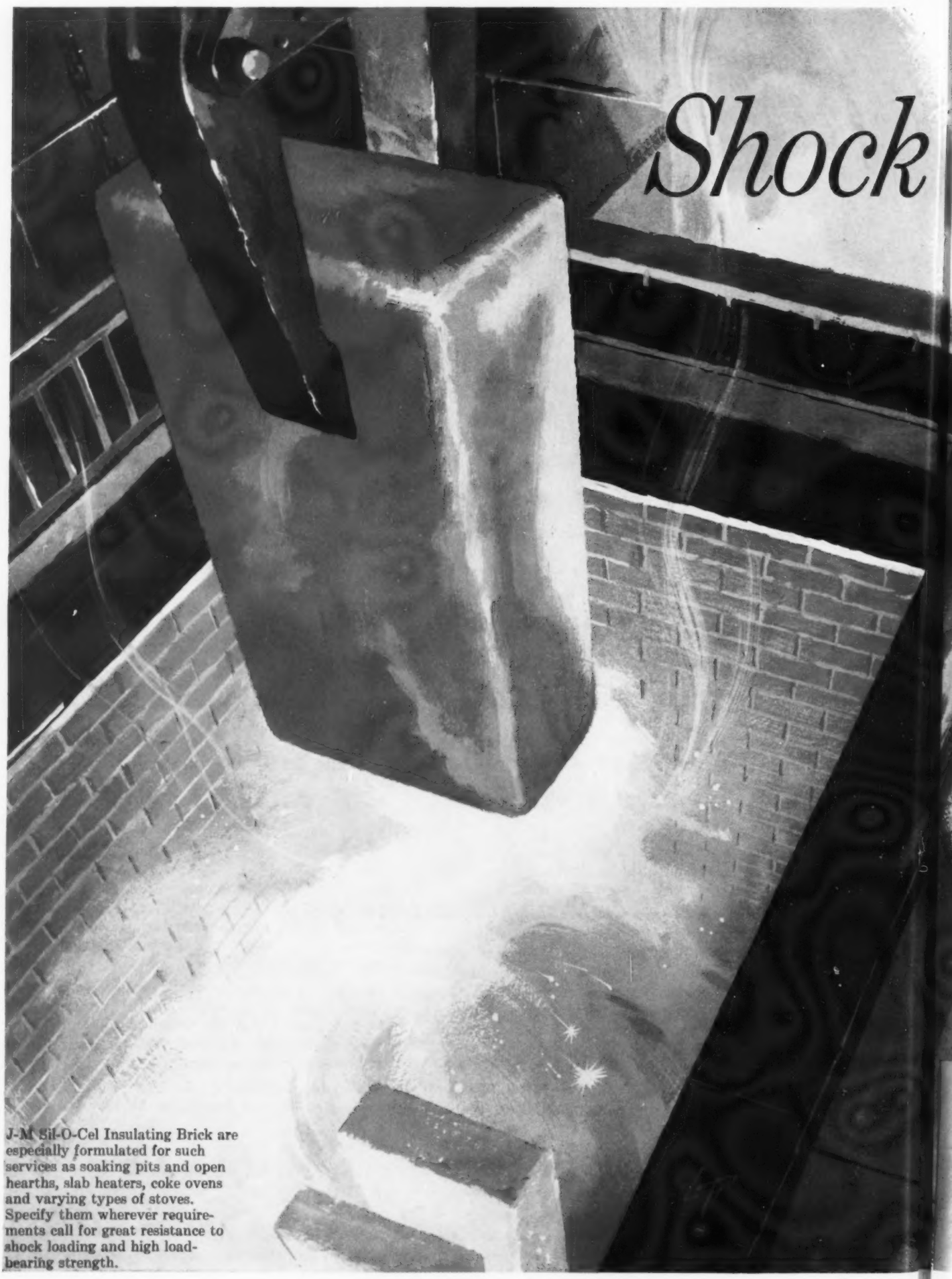
THE ELECTRIC FURNACE CO.

Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

300 West Wilson Street *Salem - Ohio*

SUBSIDIARIES — Turnkey Engineering Company, Inc., South Gate, California • Canefco Limited, Scarborough, Ontario
ENGINEERING & SALES REPRESENTATIVES — 2842 West Grand Blvd., Detroit 2, Michigan and 968 Coleman Rd., Cheshire, Conn.



J-M Sil-O-Cel Insulating Brick are especially formulated for such services as soaking pits and open hearths, slab heaters, coke ovens and varying types of stoves. Specify them wherever requirements call for great resistance to shock loading and high load-bearing strength.

loads...and crushing weight

call for Johns-Manville Sil-O-Cel Insulating Brick!

Hot blast stove walls, open hearths, soaking pit bottoms—the unexcelled performance of J-M Sil-O-Cel® brick in rugged services like these explains their wide acceptance. Today, they are used as back-up insulation by virtually every major equipment builder.

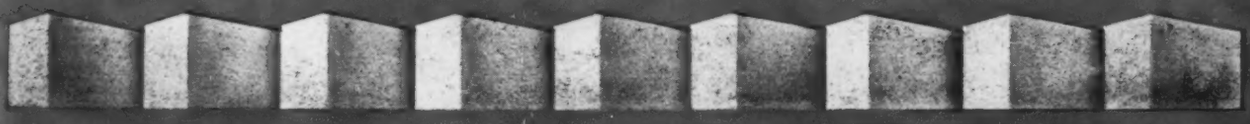
Made of heat-resistant diatomaceous silica, Sil-O-Cel Insulating Brick are produced in three load-bearing types: Sil-O-Cel *Super* (to 2500F) and Sil-O-Cel *C-22* (to 2000F) for peak performance and long life under extremes of heat, weight and shock. Sil-O-Cel *16L* combines performance and economy for lower temperatures to 1600F.

To bring you the right brick for your needs, Johns-Manville *also* offers six Insulating Fire Brick types. This wide selection of Insulating Fire Brick lets you choose the *one* brick that gives you the most favorable combination of temperature resistance, strength, conductivity, density and cost.

Write today for your copy of IN-115A, 8-page booklet on Johns-Manville Insulating Fire Brick. It gives complete physical and thermal properties of each type, along with sizes and shapes available. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK



JM-3000 service to 3000F | JM-28 service to 2800F | JM-26 service to 2600F | JM-23 service to 2300F | JM-20 service to 2000F | JM-1620 to 1600F exposed; to 2000F back-up | Sil-O-Cel® Super to 2500F back-up | Sil-O-Cel C-22 to 2000F back-up | Sil-O-Cel 16L to 1600F exposed or back-up

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

With slabbers, the cooler the rolls, the longer they last

We have been somewhat concerned during the last year or so by what seems to us a more than normal number of premature roll failures in universal slabbing mills. These failures have not been limited to any one brand of rolls.

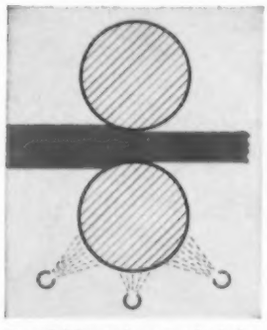
As a result, we have been checking among the many users of universal slabbers of our acquaintance, and in particular, with the operators whose mills have been giving them good outputs between roll replacements.

We think we have the answer to part of the problem, and will pass it along to you. Even if you don't operate a slabbing mill, you may find it helpful in connection with hot mill operation in general.

Not enough water. In every troublesome case that has come to our attention, too little cooling water was reaching the bottom roll, either because of an inadequate cooling system, or clogging of the spray header. Here is the way two steel plants are currently taking care of the problem:

CASE A: Water is applied to the top roll by means of a water box, with wipers on both entry and delivery sides. Three 4-inch pipes spray the bottom roll, one directly beneath the roll and the other two on the entry and delivery sides. When this mill was first installed, it had only one pipe directly beneath the bottom roll, which resulted in frequent roll breakage.

This mill is particularly careful about bringing the rolls up to working heat before beginning production. Standard practice is to pass two ingots three or four times through the mill, taking very mild reductions, with the water valves opened only half way. The two "start-up" ingots are then sent back to the soaking pit, the water is turned up to full pressure and a new, hot ingot is brought up to start the turn's regular production run.



Good blooming and slabbing mill roll-cooling arrangement utilizes two or more water lines to the bottom roll, which is usually the first to show signs of premature failure.

CASE B: This mill as delivered had only one spray header underneath the bottom roll. Bad fire cracking and roll breakage occurred almost from the day the mill was placed in production. Study of the mill showed that scale was lodging between the water pipe and the bottom roll, so that little if any cooling water was reaching the roll. Two additional water lines were brought in, each delivering its water about half way up the side of the roll. The general problem has been effectively solved by this expedient. Today, this mill at times rolls up to 140,000 tons before the rolls are redressed although normal practice is to change rolls after approximately 75,000 tons.

This is the mill described in Case A; it has an excellent record, thanks to careful control of heat in the rolls and the avoidance of sudden temperature changes.

Mack-Hemp has evolved a number of roll analyses that are especially good for slabbing and blooming work because of their combination of strength and resistance to fire cracking. Mack-Hemp *Technalloy* rolls cast from chrome-moly steel and specially heat treated offer excellent resistance to fire cracking and breakage under the most severe operating conditions. Mack-Hemp *Superalloy,* a nickel-chromium-molybdenum steel roll, turns in outstanding performance in blooming mills where side wear and fire cracking in the passes has been severe.

Whatever your problem of roll use, you'll find that Mack-Hemp can provide useful advice or helpful suggestions. We've been accumulating data on roll performance for more than a century and a quarter . . . it's yours for the asking. 'Phone or write us at any time.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery

Don't bust a blood vessel

Use the New TELECRANE®

FM Carrier Communication System

If it's necessary to whistle, shout or wave arms to communicate with crane and equipment operators in your plant, you're flirting with accidents, encouraging work lags, and inefficient operations. You can avoid them all with a system of direct, two-way voice communications.

Union Switch & Signal offers this system at a surprising low cost. The basic equipment includes transmitter-receiver units, loudspeakers, and microphones, and there is a full line of accessories to provide complete flexibility in design. Your own plant electricians can install the system—it uses existing electrical circuits. The system is easy to use—no special training needed. There's no transmission noise or outside interference—voice comes through loud and clear, and there's lots of audio power for your noisiest location.

Union Switch & Signal Carrier Type communication systems are used extensively in steel, railroad, and mining operations. The equipment is rugged and dependable, and uses the very latest and best developments in electronic circuitry. Don't miss this chance to improve your operation. Check the coupon.

Visit our Booth 487 at the Iron & Steel Exposition,
Cleveland Auditorium, Sept. 27-30, 1960

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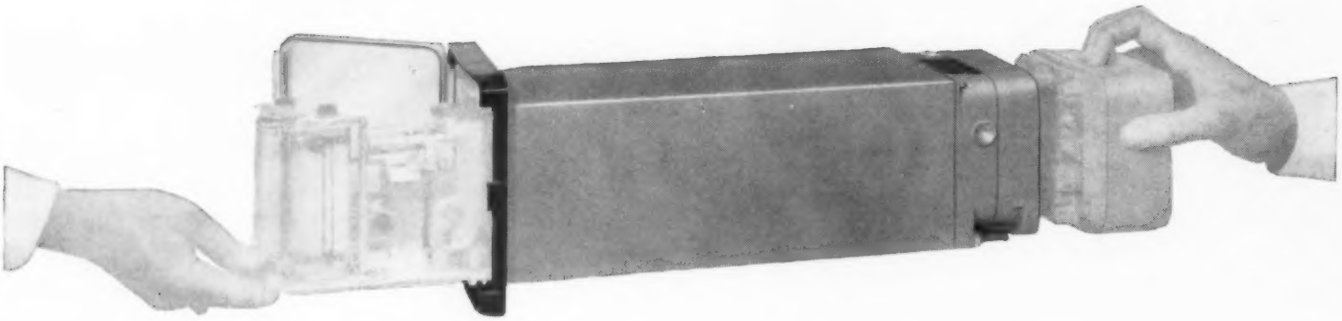

NOW we can give you 2-4 weeks delivery on TRANSCOPE* pneumatic and electronic recorder housings

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Taylor Instruments **MEAN ACCURACY FIRST**

BETHLEHEM STEEL
New!
Now Bethlehem forges every hardened steel roll from vacuum-degassed steel!
On the following pages, see why you should look for the packing of the rolls you buy.

Bethlehem vacuum-degassed steel minimizes the hazard of roll breakage

Pint size, king size, every in-between size. Now Bethlehem forges *every* hardened steel roll from vacuum-degassed steel.

Pioneer in "vacuum casting"

Bethlehem pioneered the development and use of vacuum-degassed ingots for highly stressed applications in the electric power, atomic energy, and other industries.

Our advanced steel-pouring techniques now permit us to pour molten steel from a furnace ladle to a secondary ladle within a vacuum chamber, and thereby remove harmful gases (we can also pour directly into a mold in the vacuum chamber). The secondary ladle is then taken out of the chamber and ingots of suitable size for hardened steel rolls can be cast under a blanket of inert gas.

Less gas means sounder steel

Because the vacuum-casting method reduces the volume of hydrogen and other gases, the steel is sounder, tougher, and cleaner than air-cast steel. It is this greater internal soundness which reduces the hazard of roll breakage.

Over 350 rolls now in service

In the past several years, we've produced and shipped over 350 large, vacuum-degassed hardened steel rolls. The outstanding performance of these rolls confirms our own production experience, which clearly proves the superior soundness of vacuum-cast rolls as compared to air-cast rolls.

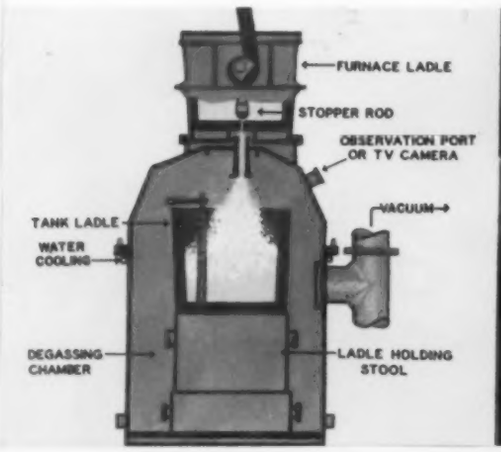
Fast delivery . . . no extra cost

You have everything to gain (less roll breakage), nothing to lose (no price extra) by making your next purchase of hardened steel rolls Bethlehem vacuum-degassed rolls. Deliveries are excellent. Our sales offices are ready to give you the *whole* interesting story of this new Bethlehem development. Call or write the office nearest you today. Or write to us at Bethlehem, Pa.

STEEL IS TAPPED from the furnace into the furnace ladle. The furnace ladle is then attached to the vacuum tank, and the molten metal pours through a vacuum-tight seal into either a secondary ladle or a mold inside the degassing chamber. If poured into a ladle, ingots can be subsequently cast from this ladle under a blanket of inert gas.

TV TELLS HIM WHAT'S GOING ON. One TV camera peers inside the high-vacuum chamber into which the hot steel is gushing and shows the stream coming from the furnace ladle (top screen). Another camera, whose picture appears on the bottom screen, shows the action of the hot steel as it flows into either the secondary ladle or the mold set up inside the vacuum tank.

ULTRASONIC SOUND WAVES, pitched so high you can't hear them, penetrate every inch of the Bethlehem vacuum-degassed roll you see here. The waves relentlessly search out any possible inner discontinuities which, if present, would be indicated on the screen. When the Bethlehem inspector gives his OK, you can rely on the soundness of that roll.



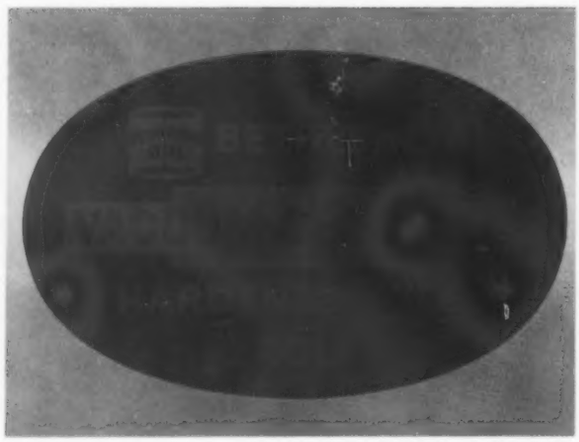
BETHLEHEM VACUUM-DEGASSED ROLLS are made for every application—cold-rolling steel sheet, strip, tinplate, and non-ferrous metals. Every roll meets your specifications *exactly* on size, shape, hardness, and finish.

BETHLEHEM STEEL

BETHLEHEM STEEL

CHECKING EVERY DETAIL is more than a routine habit in the making of Bethlehem vacuum-degassed forged rolls. It's done with an extra measure of thoroughness, extra care—from the analysis of the steel to the critical inspection of the finished product.

These are the new symbols of quality for hardened-and-ground forged steel rolls



LOOK FOR THIS LABEL on the packing of the hardened steel rolls you buy. It's your guarantee that your rolls are forged from Bethlehem vacuum-degassed steel . . . steel that minimizes the hazard of roll breakage in your plant.

LOOK FOR THIS "V" STAMP on the ends of the rolls you buy. . . . "V" is for vacuum. You'll find this permanent identification on every Bethlehem roll from now on . . . because from now on Bethlehem forges hardened steel rolls *only* from vacuum-degassed steel.

For strength
. . . economy
. . . versatility

Steel

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . patents reviewed cover period April 5, 1960 to April 26, 1960

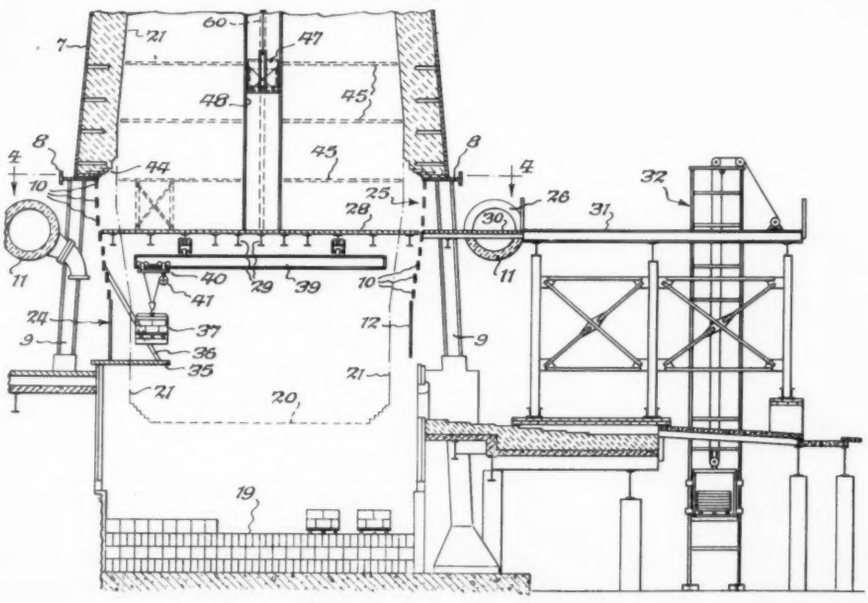
METHOD OF LINING BLAST FURNACES

△ U. S. 2,933,918, issued April 26, 1960, to Ellis L. Arnold and assigned to A. E. Anderson Construction Corp., describes a method of lining blast furnaces in a minimum of time. The method is such that the operation of lining the furnace may be carried on simultaneously in the upper portion and in the lower portion of the furnace and in a manner to incur the minimum risk of damaging any of the lining bricks or blocks.

As shown in Figures 1 and 2, at the start of the lining operation, an opening 24 is provided through which workmen and lining material may enter for working on the floor or base and on the lower part of the lining. Another opening 25 is provided to let the workmen and material enter for lining the upper portion of the furnace. This is most readily done when a furnace is to be relined by means of metal cutting torches which may cut out a portion of the annular wall 12 and another entrance 25 is formed by cutting through some of the upper bosh bands 10 of the furnace. This opening 25 is preferably formed immediately below the mantle 8. In order to gain entrance below the mantle, it is generally necessary to remove a portion of the bustle pipe as shown at 26.

One of the first operations in preparation for the actual lining of the furnace is to provide within the furnace at the level of the upper entrance 25 a deck 28 mounted on beams 29, the ends of which may be secured by welding to some of the bosh bands of the furnace.

Figure 1



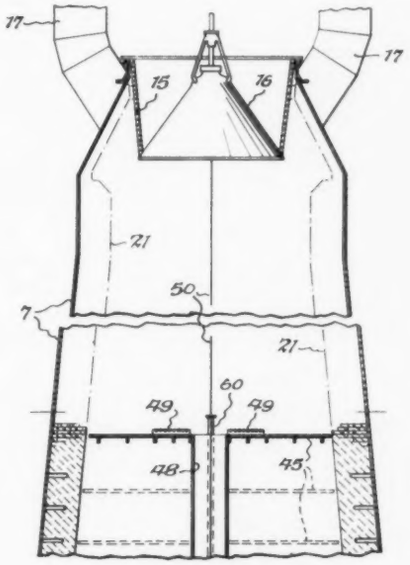


Figure 2

This deck is left in position in the furnace during the lining operation and serves as a support for an elevator and a hoist for use both in lining the upper and the lower portions of the furnace. This deck is connected by means of a platform or gangway 30 with a platform 31 mounted on a suitable structure on the exterior of the furnace, and a hoist or elevator 32 is provided for transporting material from the ground level to the platform 31.

At the entrance 24 to the lower portion of the furnace, an elevator platform 35 is mounted within the furnace, that shown being partly suspended by rods or cables 36, the upper ends of which may be welded to some of the bosh bands. This elevator platform is arranged at such elevation that lining material may be readily deposited on it, for example, by means of a lift truck. A cage 37 is open at the

bottom so that it may be lowered over the pallet and the bricks supported on it and secured to the pallet.

This hoist is suspended from a track beam 39 in the form of an "I" beam which is mounted by means of trolleys on some of the supporting beams 29 for the deck 28 so that the track beam may move back and forth underneath the deck by means of the trolleys which operate on the "I" beams 29 supporting the deck 28 so that the track beam may move back and forth underneath the deck by means of the trolleys which operate on the "I" beams 29 supporting the deck 28. The track beam 38 supports a carriage 40 on which the cage 37 is supported by a suitable cable suspended from the carriage 40. The cable connects with a winding drum 41 driven by power to raise and lower the cage 37.

In order to incur the minimum of risk of damage to the bricks or blocks used in the lining, they are positioned on pallets at the factory, and the bricks are arranged in groups which are protected by cardboard and banding. The pallets supporting the bricks are loaded on railroad cars or trucks at the plant where they are made, and at the furnace which is being lined the pallets are raised by means of a lift truck and deposited on the elevator platform 35. The pallet may then be hoisted by means of the hoist mechanism mounted on the carriage 40 and may be raised off of the elevator platform and positioned to any part of the furnace floor or wall lining where the brick are required. By means of the track beam and the carriage 40, the pallets may be positioned in any portion of the lower part of the furnace where they may be required and the bricks are then removed from the pallet by the bricklayer.

During the operation of lining the upper part of the furnace, other bricks also on pallets are raised by means of the elevator 32 to the platform 31. The pallet on which the bricks are mounted may then be placed on a ramp which may include roller units along with the pallet of bricks is moved along the platform 31 and the gangway 30 to the deck 28. While the lining for the lower part of the furnace is being constructed, the lining for the upper part is also begun by laying brick on the mantle 8, and a corbel construction 44 is employed at the beginning of the lining of the upper part of the furnace.

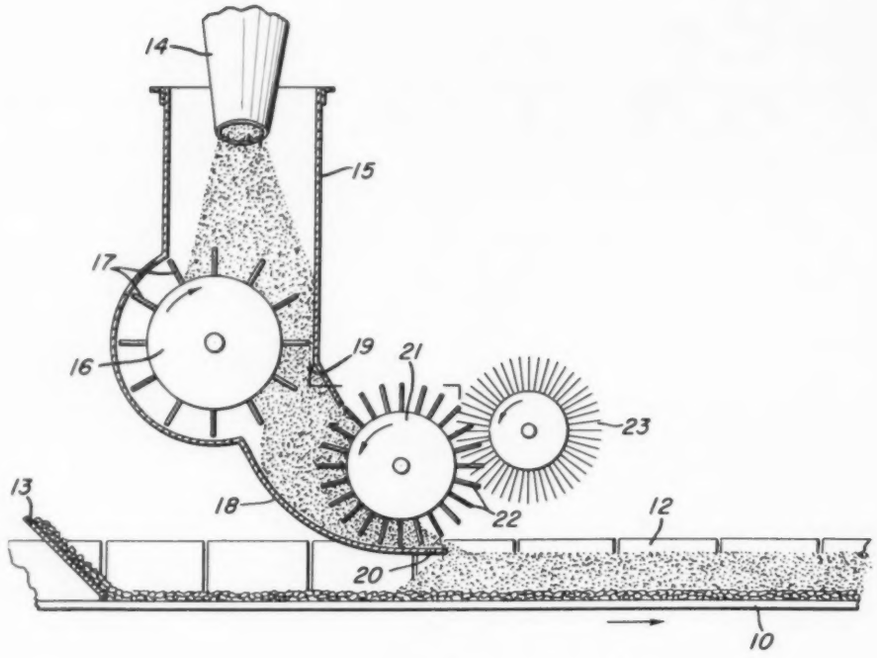


Figure 3

After the lining bricks have been positioned on the mantle to a height which can be conveniently reached by bricklayers standing on the deck 28, scaffolding of any usual or suitable type is erected on the deck on which platforms 45 are successively supported. The pallets are supplied to the platform 45 by means of an elevator 47 arranged within an elevator shaft 48. The elevator shaft is provided with openings wherever necessary to permit pallets and brick to be placed on the elevator 47, and suitable openings are provided in the elevator shaft through which the pallets are removed from the elevator for placing them into convenient positions for bricklayers working on one or other of the platforms 45. Suitable roller platforms 49 may be employed to facilitate moving the pallets to the desired locations on the platforms. The elevator 47 is supported on a cable 50 mounted in the upper portion of the furnace.

APPARATUS FOR FEEDING A SINTERING MACHINE

△ U. S. 2,933,306, issued April 19, 1960, to Floyd E. Davis and Bronnie F. Krane, provides an apparatus for feeding material to a traveling grate sintering machine, in which feed material discharges from a hopper to a chute in carefully controlled volumes, and is subjected to a fluffing action in the chute immediately preceding deposition on the grate, so that the resulting sinter bed is uniform in depth and highly porous.

As shown in Figure 3, a swinging spout 14 feeds the main portion of the sinter mix to a hopper 15 above the grate. A feeder drum 16 is journaled in the lower portion of the hopper and carries uniformly spaced radial blades 17 extending from its circumference. The drum is driven continuously at a uniform rate clockwise and thus delivers an even flow of material which is uniform across the width of the grate. A chute 18 extends downwardly from an opening 19 in the hopper below the drum 16 for receiving material from the latter. The chute terminates in a substantially horizontal lip 20 spaced above the grate 10 a distance equal to the desired bed depth. A fluffing drum 21 is journaled in the chute above this lip and carries radial spikes 22 extending from its circumference. This drum is continuously driven counterclockwise, and its spikes continuously fluff the feed material just before deposition on the grate. Preferably a rotating bristle scraper 23 is journaled above the drum to clean

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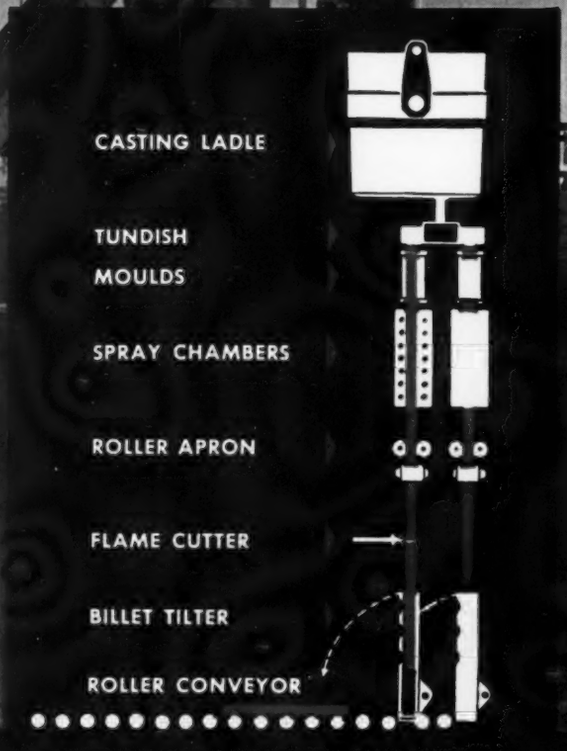

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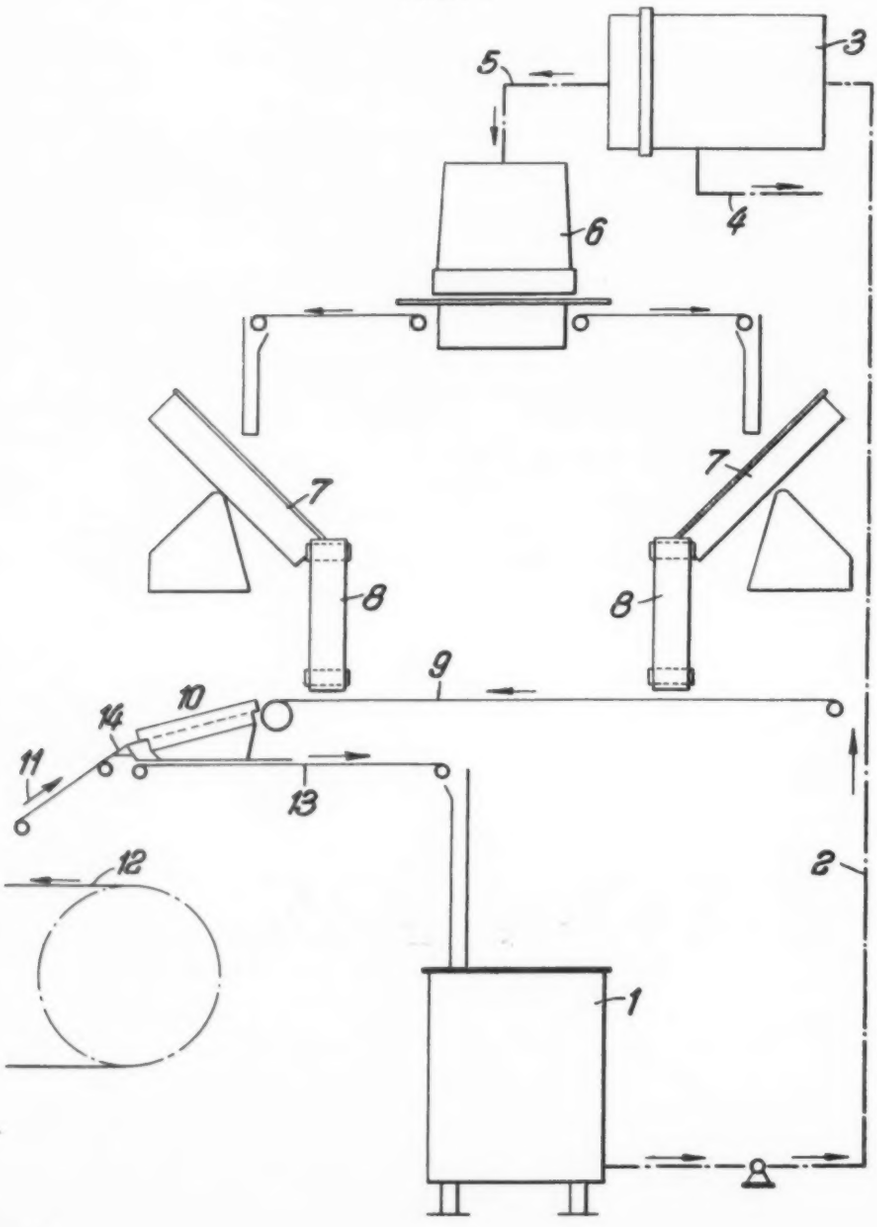
off any material that tends to cling.

PROCESS FOR PROVIDING SINTERING BED PELLETS

△ U. S. 2,934,421, issued April 26, 1960, to Kurt Meyer and assigned to Metallgesellschaft Aktiengesellschaft, provides a process for the granulating, agglomerating, or other binding together of fine particles into relatively coarse granules or pellets for use in a sinter bed. The object of the invention is to provide a process in which the green pellets are produced and used upon a sintering grate without the disadvantages of stock piling them during stoppages of the sintering apparatus. In general, this object is accomplished by operating the granulating apparatus so that it produces a constant quantity of granules which at least corresponds to the quantity required for forming the bed of the sintering grate. Any excess of green pellets is immediately returned to the raw supply for the granulating apparatus.

As shown in Figure 4, the raw material is contained in raw material storage tank 1 having a stirrer in it, and is pumped through pipe 2 into filter unit 3 where excess water is removed and discharged through pipe 4, and leaving the material in suitable condition for being granulated. The concentrated material flows through pipe 5 into a rotating vessel 6 which distributes the material to conveyors which pass the material to one or the other of a number of granulators which may be pelletizing disks 7. The fresh green pellets formed by granulators 7 are conveyed by inclined belts 8 running reversely to the flow of material, from which the pellets are deposited upon a horizontal conveyor belt 9. From conveyor 9 the pellets flow onto a screen 10 and over a feed belt 11 to place pellets of sintering bed usable size onto the sintering grate or belt 12. Screen 10 removes the small-sized granules which drop onto return conveyor belt 13 which brings the fine granules back into raw material tank 1.

Figure 4



The output of the pellet producing means is set to be a quantity at least as great as that required for the maximum capacity of sintering grate 12. If the capacity of grate 12 drops below the production rate of green pellets, the excess pellets of usable size are by-passed to return conveyor 13. This can be accomplished simply by means of a trap door 14 arranged at the outlet end of screen 10. However, the by-pass return conveyor can also be advantageously accomplished by using a depositing belt 11 which moves in a direction opposite to that of the downward flow of the granules thereover. At its normal speed of operation, this movement of depositing belt 11 brakes or reduces the falling velocity of the green pellets so that they will not be damaged when dropped onto grate 12. If a part or all of the green pellets are to be returned to belt 13, it is only necessary to increase the speed of belt 11 to such an extent that either some or all of the pellets are carried onto conveyor 13.

Inclined belts 8 are also moved in a direction counter to the flow of the green pellets, thus reducing their falling velocity. By regulating the speed of belts 8, a further granulation of the smaller particles coming from disks 7 can be obtained, this additional granulating being to such an extent that the greater portion of the granules reaching conveyor 9 are of a desired size.

AUTOMATIC CONTROL OF THE MOISTURE IN A SINTER MIX

△ U. S. 2,931,718, issued April 5, 1960, to Melvin J. Greaves and assigned to Arthur G. McKee & Co., describes a method and ap-

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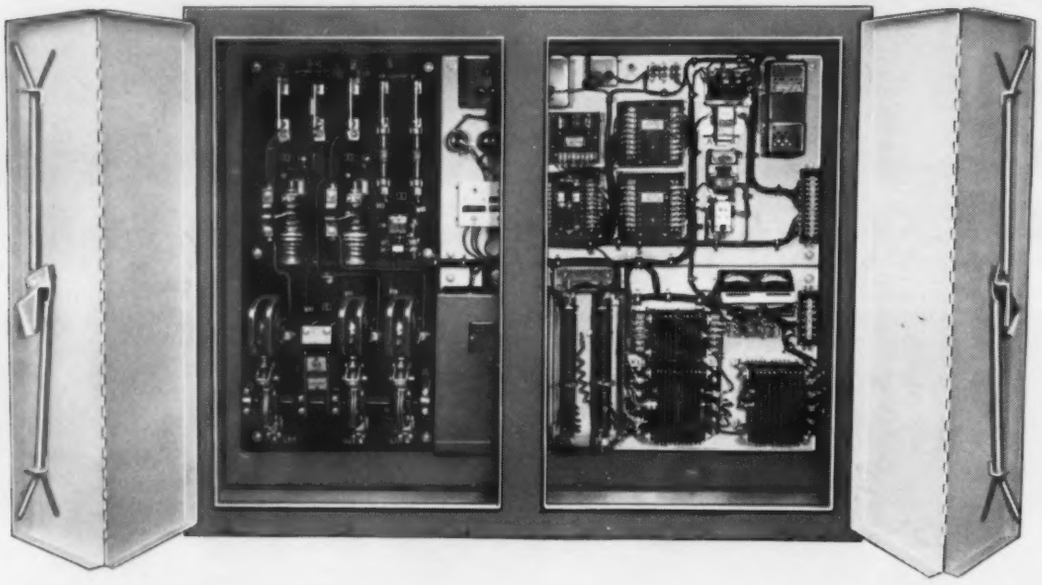

EC&M's New STATA-Hoist is an AC Reactor Hoist Control which provides the ultimate in load-handling accuracy. STATA-Hoist Control offers these outstanding advantages:

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Fewer Collector Bars than any other system

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paratus for automatically and continuously measuring and controlling the moisture content of sinter mix that is supplied to a continuous sintering machine.

The method consists of adding steam to a continuously withdrawn sample of ambient air to form an air-steam mixture, the steam being added in quantity sufficient to make the moisture content of the air-steam mixture equal to that of a simultaneously withdrawn sample of the stack gases from the sintering machine, continously measuring the rate of flow of the steam and the rate of flow of the air-steam mixture and determining the ratio there between. This ratio varies when the amount of moisture in the stack gases that comes from sources other than the air supplied to the sinter bed varies. The rate of flow of the stack gases is continuously measured and said ratio is applied to said rate of flow of the stack gases to obtain a varying indication of the quantity of other than ambient air moisture in the stack gases. By continuously measuring the rate of feed of the mix, and dividing the quantity of other than ambient air moisture by the rate of feed of the mix, a continuous indication of the moisture content of the mix as supplied to the sintering machine is obtained.

Figure 5 shows a flowsheet of the process. The moisture comparator

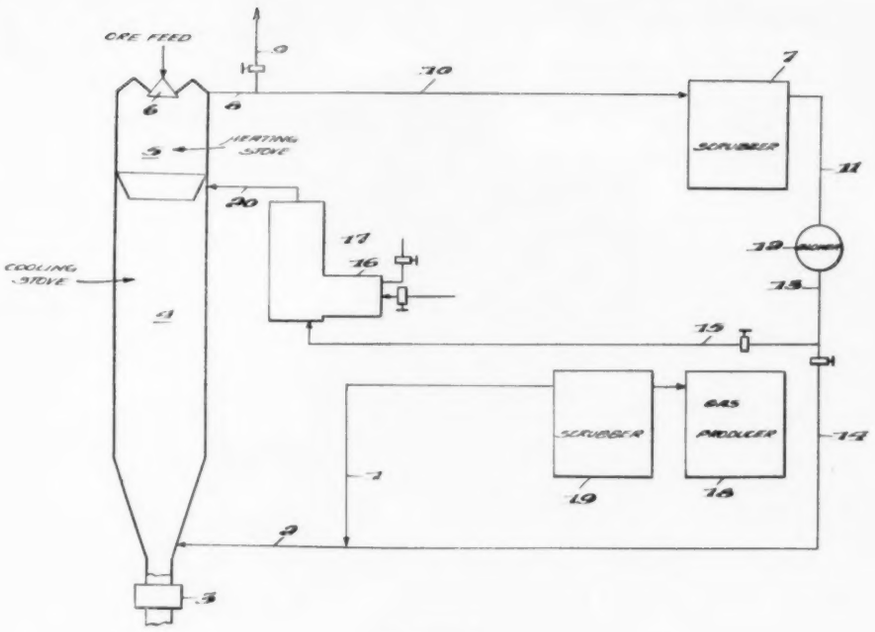


Figure 6

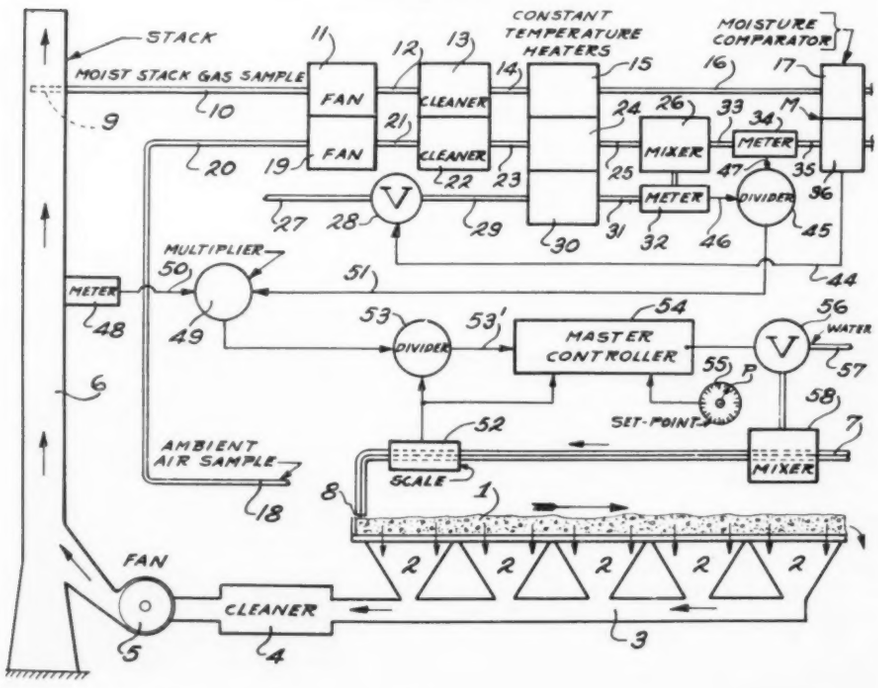
17 operates on the principle that heteroatomic gases absorb infrared energy of various discreet characteristic wave lengths. This absorption increases the temperature, and hence the pressure, of a fixed volume of gas proportional to the amount of energy absorption.

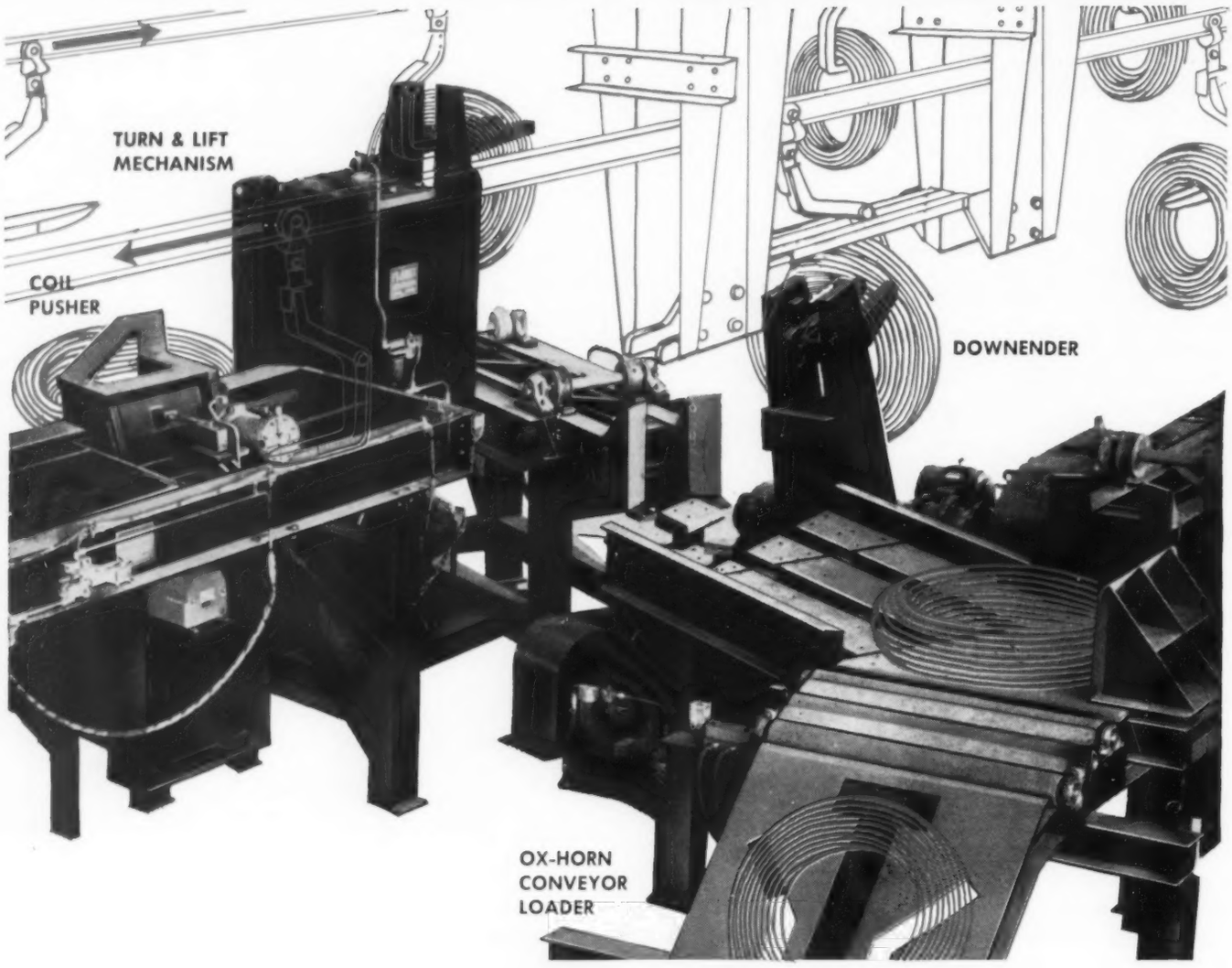
BENEFICIATION OF LOW-GRADE HEMATITIC ORE MATERIALS

△ U. S. 2,931,720, issued April 5, 1960, to Fred D. DeVaney and assigned to Pickands Mather & Co., describes a process for the beneficiation of low-grade hematitic ore materials in which the non-magnetic iron mineral is too fine grained to be concentrated by gravity methods.

In Figure 6, the reducing furnace is a vertical shaft composed of a lower cooling stove 4 and an upper heating stove 5. Heating stove 5 is provided at its top with a double bell-and-hopper feeding means 6 for introducing feed ore into the furnace without loss of gas from the system, while cooling stove 4 is provided at its bottom with a reduced ore product discharge means 3 for positively removing reduced and cooled ore from the reducing furnace, at controllably variable rates, without loss of gas from the system. At 7 there is schematically represented a wet dust collector-scrubber for cleaning and cooling spent carrier gas exiting from the top of stove 5 by way of spent gas conduit 8. Conduit 8 is provided with a valved vent means 9 for wasting to atmosphere a small (variable) fractional part of the total spent carrier gas, and conduit 10 conducts the residual spent carrier gas to scrubber 7. In scrubber 7 the carrier gas is cooled to room temperature and the dust removed and excess moisture condensed out and expelled together with excess CO_2. The so-conditioned carrier gas is withdrawn from scrubber 7 through conduit 11 by means of blower 12, and by the latter is forced through

Figure 5





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cold carrier gas conduit 13. Conduit 13 delivers to two branch valved conduits 14 and 15, which split the stream of cold clean carrier gas for delivery to inlet conduit 2 and mixing chamber 17, respectively. A conduit 1 delivers active reducing gas, produced in gas producer 18 and cleaned in scrubber 19, to inlet conduit 2 for mixing with carrier gas to provide an enriched gas. At 16 is indicated a burner for burning fuel oil in a controlled amount of air to produce hot gaseous combustion products devoid of free oxygen, for commingling in mixing chamber 17 with clean cold carrier gas delivered to mixing chamber 17 through valved conduit 15. The hot carrier gas-neutral gaseous combustion products mixture produced in chamber 17 is, through conduit 20, introduced into the reducing furnace, at a level adjacent the bottom of heating stove 5, and passes upwardly—in association with ascending enriched gas (introduced at the bottom of cooling stove 4) with which latter it commingles—through that part of the total column of ore in heating stove 5. In such passage said hot carrier gas-neutral gaseous combustion products mixture gives up a major part of its heat to the ore thereby heating the latter to desired reduction temperature. The active reducing agent component of the enriched gas, for its part, becomes oxidized (to CO_2 and/or H_2O, as the case may be) by reaction with the Fe_2O_3 of the ore, and loses heat (acquired in passage through the ore in stove 4) to the ore in stove 5. The commingled gases exit from the top of the furnace—through conduit 8—as the aforesaid "spent carrier gas" thus completing the gas cycle of the process.

LADLE SCULLING MACHINE

△ U. S. 2,931,060, issued April 5, 1960, to William E. Kelly and assigned in part to Salvatore Compagnone, describes a rotary cutting head for sculling a ladle to remove the residue by chipping.

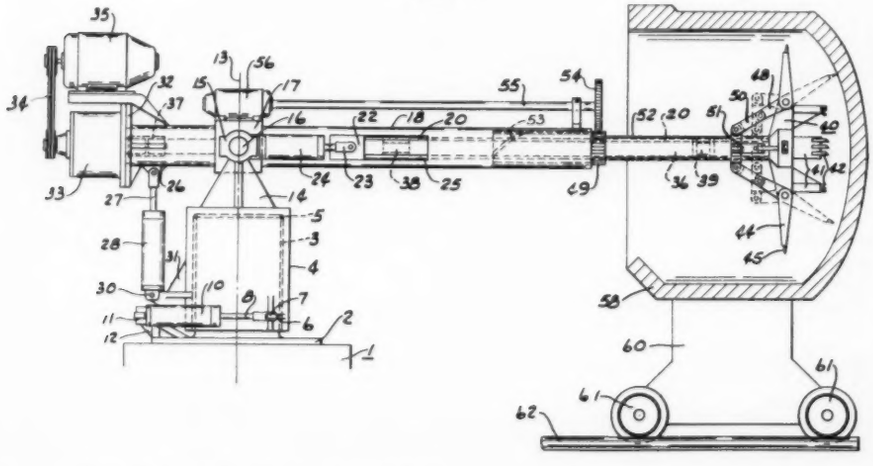
The apparatus is shown in Figure 7.

METHOD OF MAKING ZIRCONIUM-CLAD STEEL PLATE

△ U. S. 2,932,885, issued April 19, 1960, to Thomas T. Watson and assigned to Lukens Steel Co., describes a method of producing zirconium-clad steel plate which can be bent 180 degrees in either compression or tension without rupturing the bond between the metallic layers.

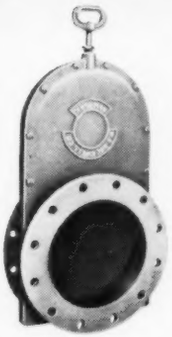
The method consists of electroplating one side surface of a zirconium sheet with iron to obtain a deposit of approximately 0.002 to 0.003 in. coating one side of a steel plate with parting material, drying the parting material, placing the unplated surface of the zirconium sheet against the dry parting material, bringing a second steel plate into engagement with the plated surface of the zirconium sheet, spacing the edges of the sheet inwardly from the edges of said plates to form a peripheral recess around the edges of the sheet, welding spacer bars between the edges of the plates to form a sealed chamber around the edges of the sheet, providing the chamber with a gas inlet and a gas outlet, flowing an inert gas through the chamber to purge it of air, heating the as-

Figure 7



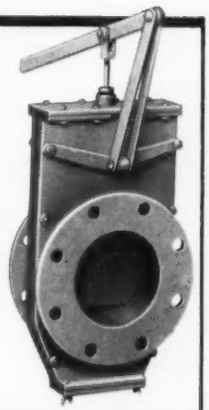
ROCKWELL SLIDE VALVES

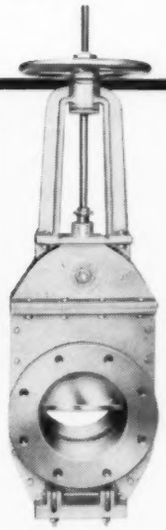
for GASES SLURRIES OR FREE-FLOWING SOLIDS THAT CLOG OR JAM OTHER VALVES...



Standard Slide Valve, screwed end type or flanged (shown); when fully open, valve offers no restriction to fluid flow. Bulletin 500R.

"Kwikleen" Slide Valve – Not necessary to remove from line for cleaning. Sediment discharged at bottom. Complete cleanout by attaching steam, water or air line to plug hole in valve body. Bulletin 501R.





Heavy Duty "Kwikleen" Valve for line pressures to 60 psi. Blade not exposed when in fully open position. Ideal for pulp stock, slurries, dust, fly ash, scale, granular materials. Bulletin 508.

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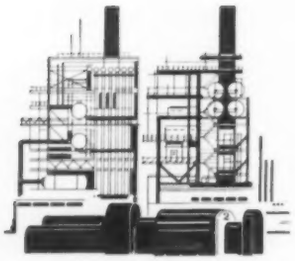
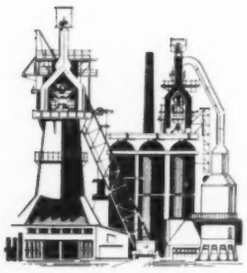
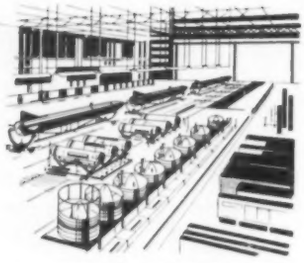


ELECTRIC POWER

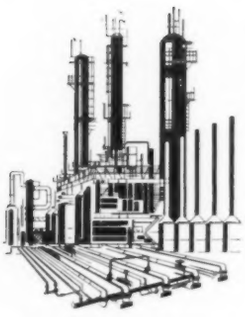


STEELMAKING

RW-300



AIRCRAFT AND MISSILES



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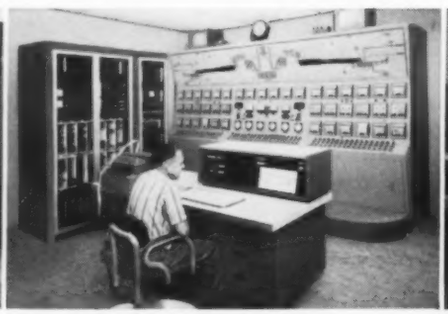

Riverside Cement Company, Oro Grande, California—cement manufacturing

Douglas Aircraft Company, Santa Monica, California—missile component testing

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sembled pack to a temperature between 1000 and 1550 F. to promote bonding of the zirconium sheet to the second plate while maintaining the flow of gas, and rolling the pack to an extent sufficient to bond the zirconium sheet to said second plate.

CONTINUOUS HEATING OF BRIGHT TINPLATE STRIP

△ U. S. 2,933,425, issued April 19, 1960, to Frederic O. Hess and assigned to Selas Corp. of America, describes a furnace for the continuous heating of bright tinplate strip, using steam as the heating medium.

As shown in Figure 8, the strip is moved vertically downward through a furnace chamber. As the strip is moved, it is heated by radiant heat and the convection heat produced by hot products of combustion to a point just below the point at which the tin coating will melt. The strip then has its temperature quickly raised to a point where the tin will flow by convection heat produced by a blast of superheated steam. The heating effect of the steam can be readily controlled, and

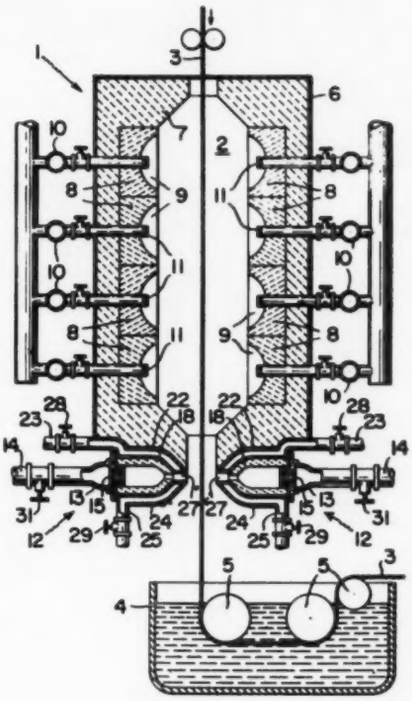
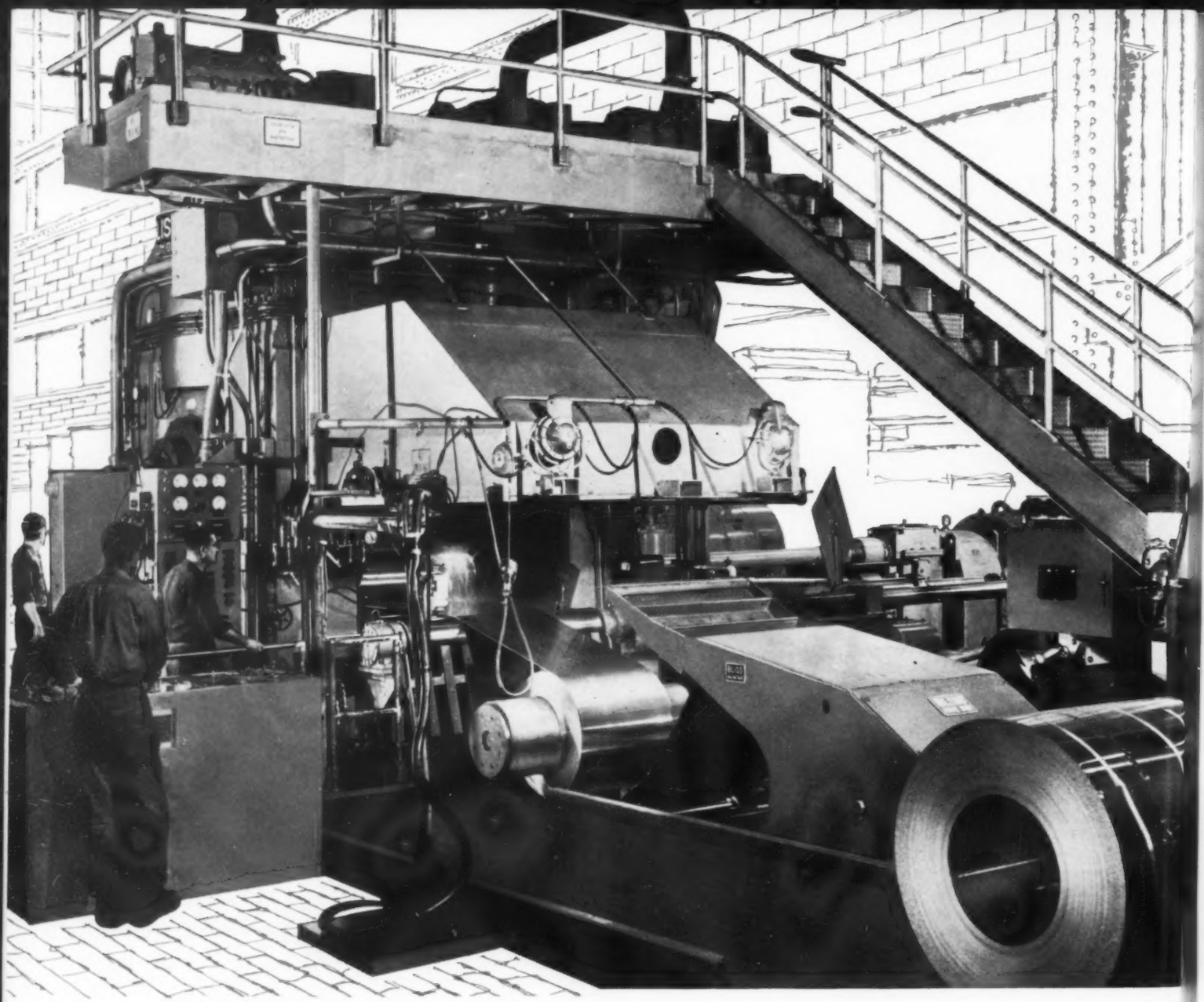


Figure 8

is considerably greater than that of lighter gases because of its greater density. Shortly after the tin is melted, the strip is cooled to set it, before it is brought into contact with any surface.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,931,635	4/5/60	Electrically operated stove changing control apparatus for blast furnaces	Zimmerman & Jansen G.m.b.H.
2,931,641	4/5/60	Apparatus for annealing bars	Aktiengesellschaft Brown, Boverie & Cie
2,931,717	4/5/60	Preparation of blast furnace feed	The Dow Chemical Co.
2,931,744	4/5/60	Grain refining centrifugal castings	United States Pipe & Foundry Co.
2,931,745	4/5/60	Reduction of chloride salts in austempering quench baths	International Harvester Co.
2,931,759	4/5/60	Solderability of tinplate	Inland Steel Co.
2,932,222	4/12/60	Form forging machine	Republic Steel Corp.
2,932,247	4/12/60	Charging box for a machine for operating on metal scrap	Harris Foundry & Machine Co.
2,932,420	4/12/60	Coil tilting mechanism	United States Steel Corp.
2,932,435	4/12/60	Latch mechanism for bottom-dump bucket	United States Steel Corp.
2,932,567	4/12/60	Production of ductile cast iron	Norman R. Evans
2,932,568	4/12/60	High-temperature alloy steel	The Carpenter Steel Co.
2,932,679	4/12/60	Fume-collecting hood for electric furnace	United States Steel Corp.
2,932,852	4/19/60	Rolling mill	Imperial Chemical Industries Ltd.
2,932,886	4/19/60	Production of heavy clad steel plate	Lukens Steel Co.
2,932,889	4/19/60	Pipe upsetting	United States Steel Corp.
2,933,094	4/19/60	Pickling bath instrumentation	Industrial Instruments, Inc.
2,933,202	4/19/60	Apparatus for handling bundles	United States Steel Corp.
2,933,261	4/19/60	Coil unreeler	Acme Steel Co.
2,933,373	4/19/60	Beneficiation of titaniferous iron ores	Titanium Metals Corp. of America
2,933,385	4/19/60	Production of nodular iron	Meehanite Metal Corp.
2,933,386	4/19/60	Sintering and nitriding ferrous bodies	Radio Corp. of America
2,933,424	4/19/60	Manufacture of cold headed wire	United States Steel Corp.
2,933,788	4/26/60	Ingot mold insert mat	Harrison D. Sterick
2,933,956	4/26/60	Automatic screwdown control system for rod mill	United States Steel Corp.
2,934,422	4/26/60	Production of ferrochromium	Strategic-Udy Metallurgical & Chemical Processes, Ltd.
2,934,463	4/26/60	High-strength steel	Ford Motor Co.



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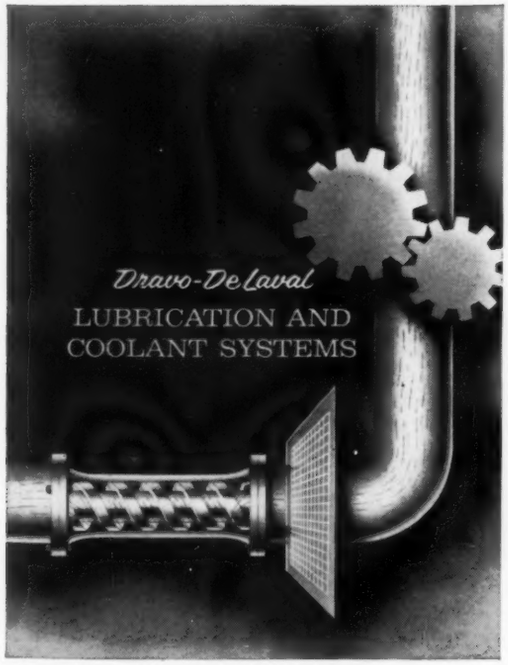

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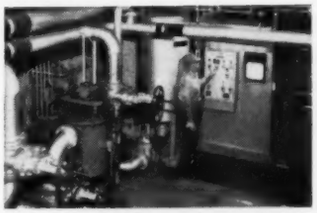

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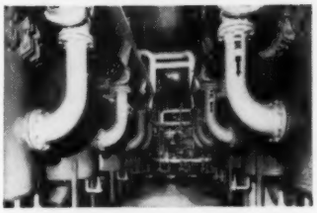

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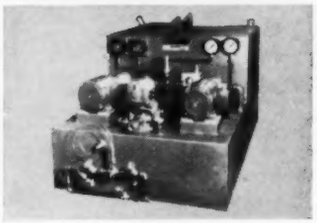

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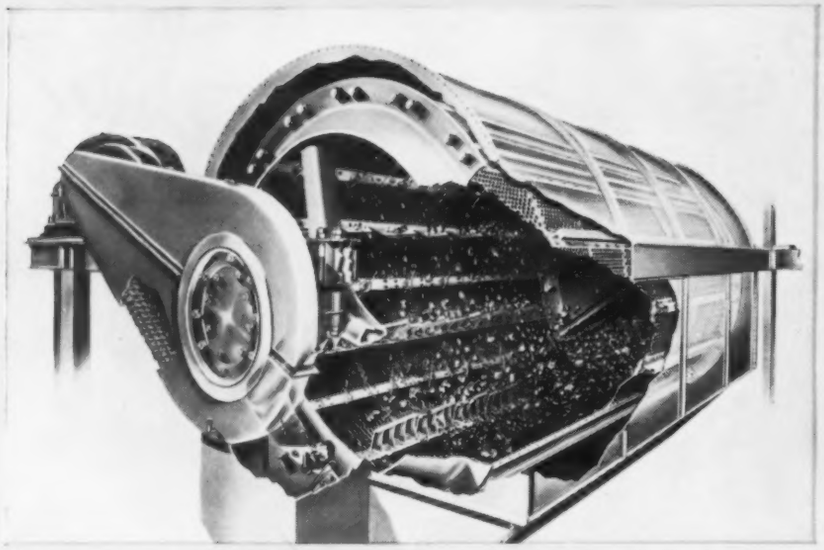

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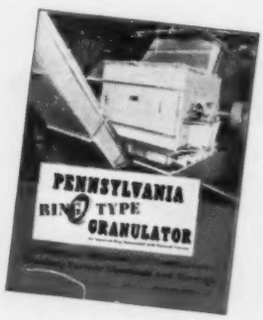

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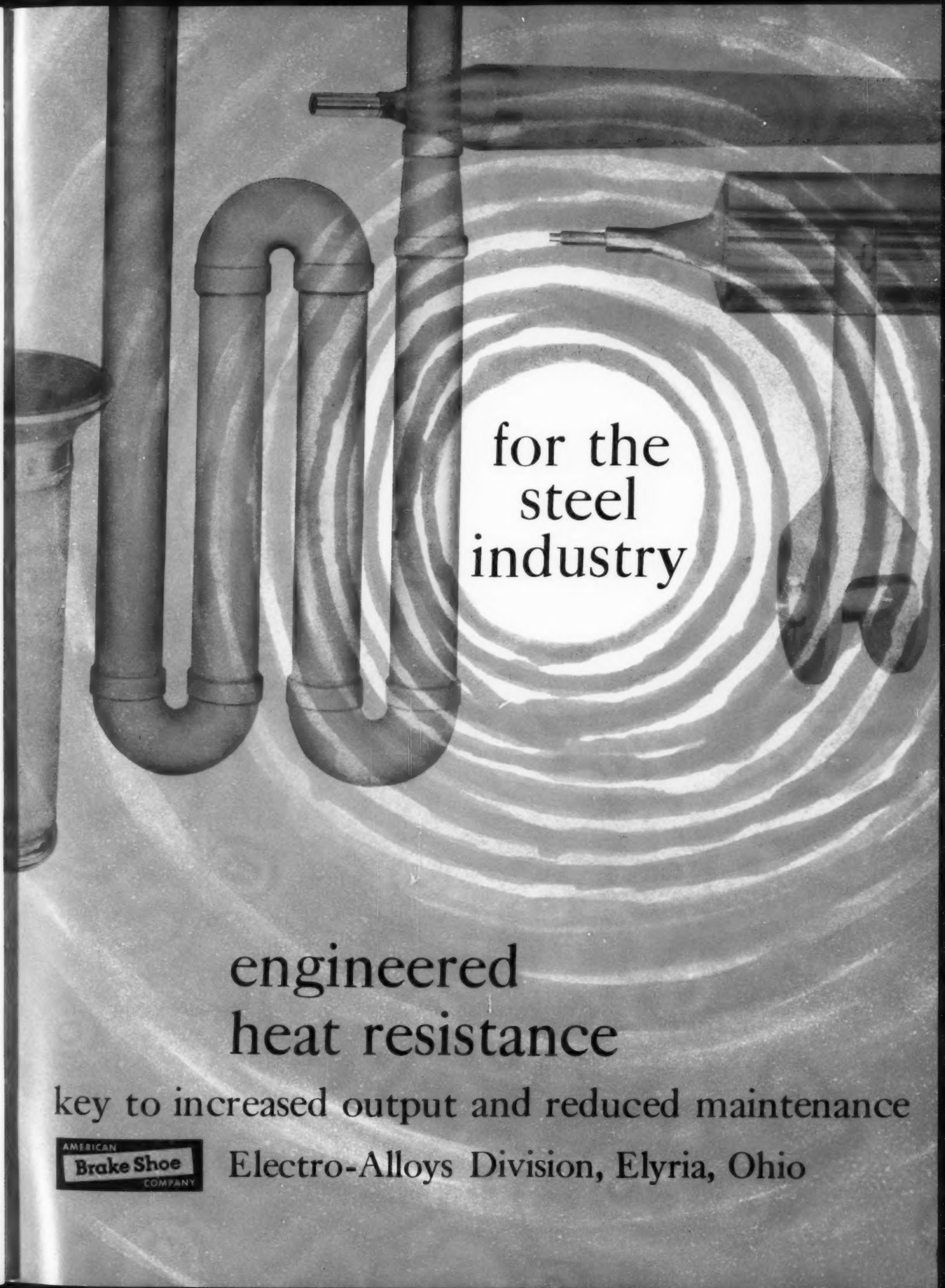
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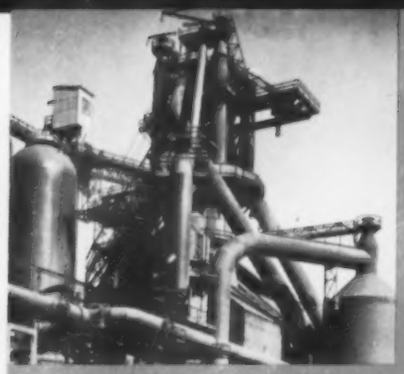
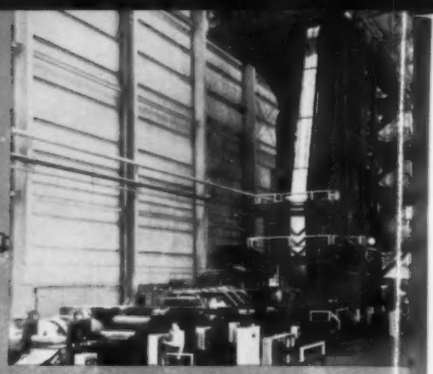


Blast Furnace Blowpipes



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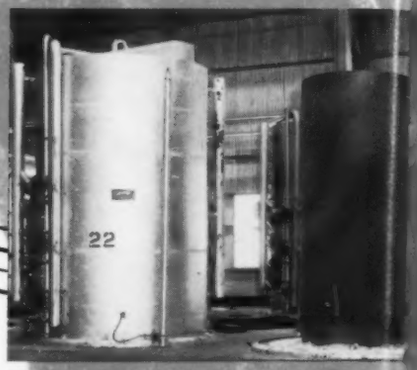
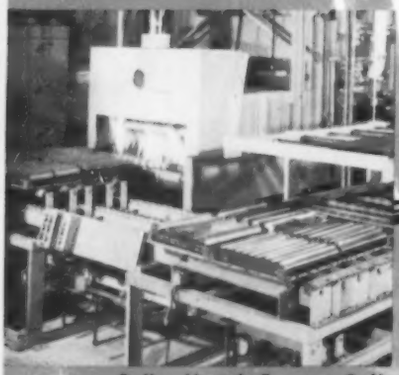
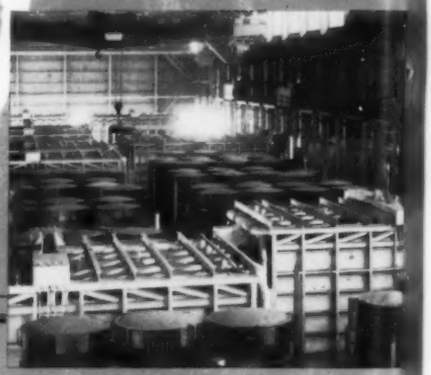


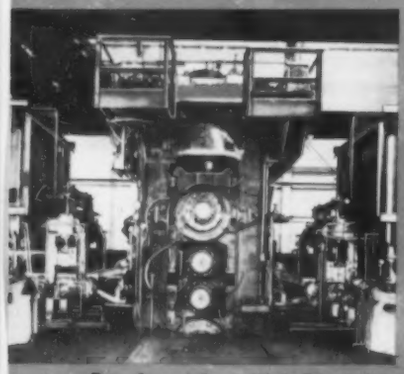
Single-Stack Annealing Furnace Radiant Tubes



Roller Hearth Furnace Rolls



Multiple-Stack Annealing Furnace Radiant Tubes



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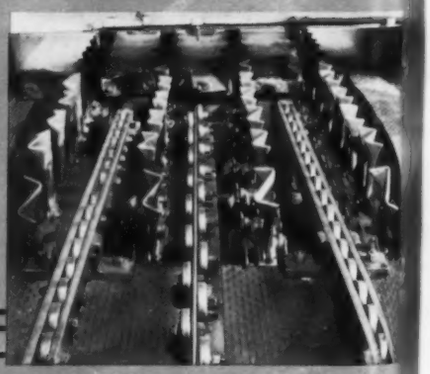

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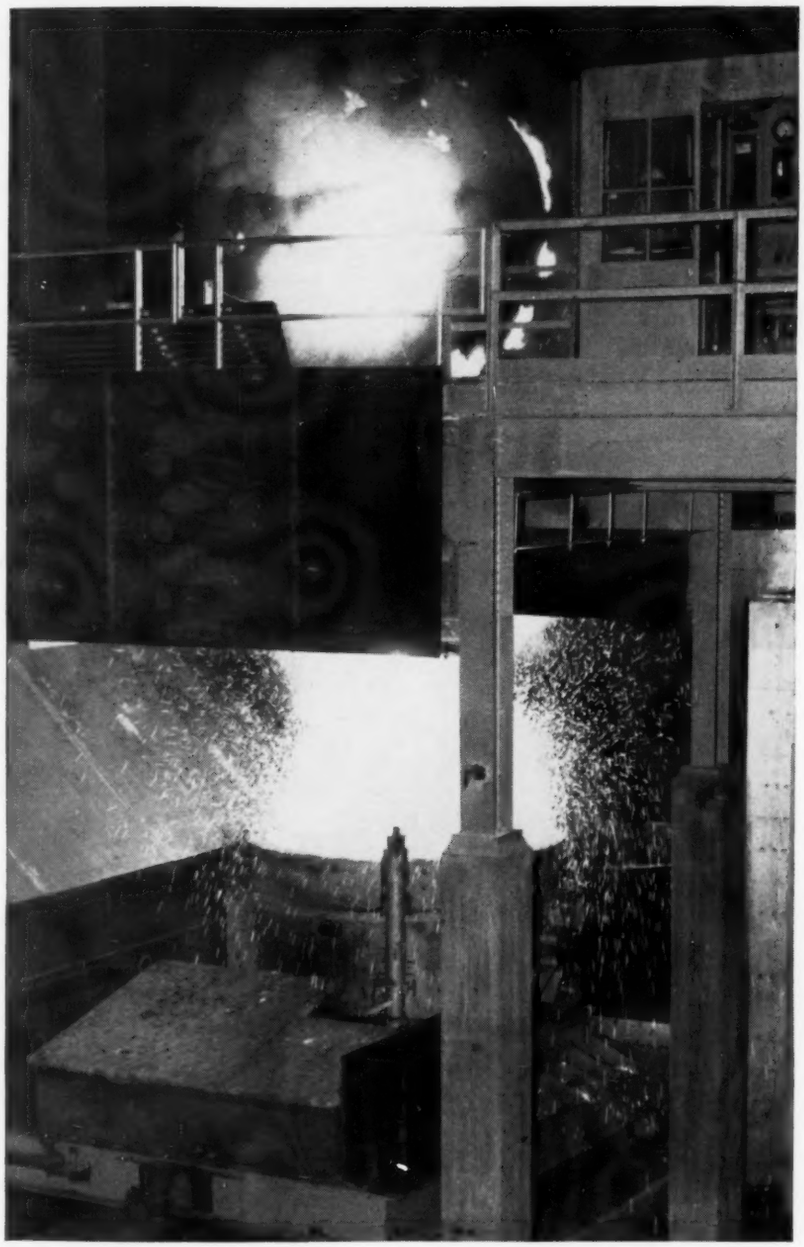

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WALSH MORT-AIRSET

Airsetting High Temperature Bonding Mortar

The ideal stopper rod cement because of its higher moisture retention and smoother working qualities. *Absolutely does not ball or gum up in the drum but is always in useable condition.* Noted for its stronger, tighter bond—desirable qualities that result in longer service life, not only on stopper rods, but wherever stronger gas-tight joints are required.

Walsh Ladle Brick installed and maintained with Walsh Metalok Mortar excel in resistance to increasingly higher temperature requirements of open hearth and oxygen converter heats at tap time as well as the greater mechanical and temperature shock brought about by the sudden velocity of metal pouring.

WALSH REFRACTORIES CORPORATION — America's Best Clays

Exclusive Agents In Ontario:
Standard Refractories, Ltd., Hamilton, Ontario, Canada

WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

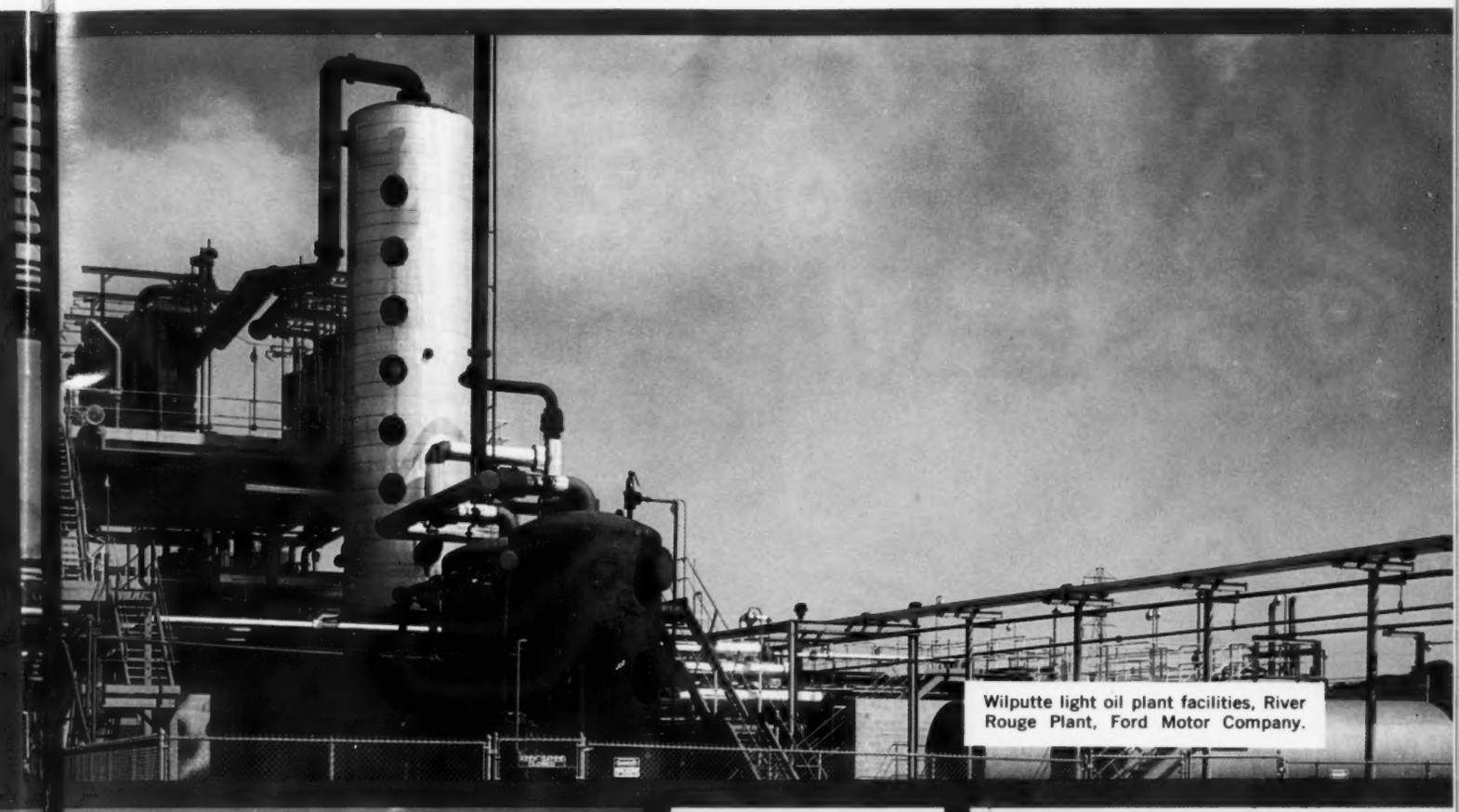
SPECIALISTS IN REFRACTORIES OF HIGH BULK DENSITY AND LOW POROSITY

WILPUTTE SEMET-SOLVAY

Battery top of 76 Wilputte underjet coke ovens at a Midwest steel mill.

Complete Wilputte coke plant at a Midwest steel mill.

DESIGNERS–BUILDERS–OPERATORS OF COKE OVENS AND COAL CHEMICAL PLANTS SINCE 1892



Wilputte light oil plant facilities, River Rouge Plant, Ford Motor Company.

Wilputte coal chemical recovery plant, Fairless Works, United States Steel Corporation.

Battery of 70 Wilputte underjet ovens, Great Lakes Steel Corporation, Detroit.

WILPUTTE COKE OVEN DIVISION
40 RECTOR STREET, NEW YORK 6, NEW YORK

Allied Chemical

BASIC TO AMERICA'S PROGRESS

River of steel on rails

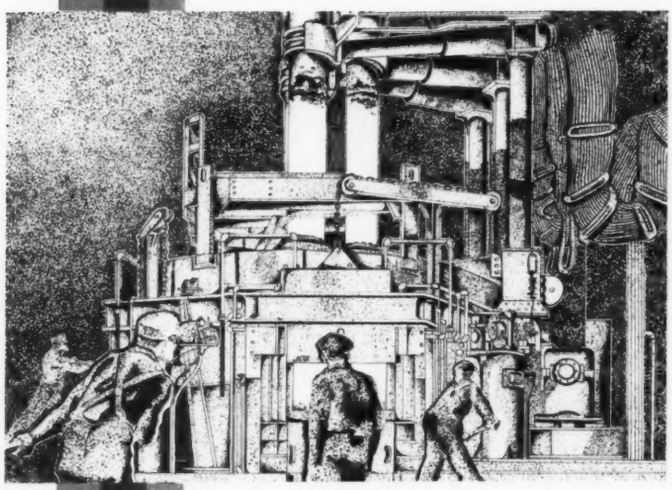
Giant molds, filled with cherry-red molten steel, roll past a nearly completed electric furnace plant en route to the stripper. United Engineers has served many of the country's leading steel producers on projects of widest scope—designing and installing such facilities as rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, and coal handling equipment. Each project demonstrates the time and cost-saving advantages in our coordination of design, purchasing, expediting and construction. We invite you to share and profit from our background of 75 years' experience as designers, construction engineers, and engineering consultants.

Painting by Stanley Meltzoff

UNITED ENGINEERS

& Constructors Inc • U.E.&C. (Canada) Ltd. • New York • PHILADELPHIA • Chicago

AN ELECTRODE'S HIDDEN VALUES EXCEL IN REDUCING MELT-TON COSTS



One electrode looks much like another—yet one will do the job economically while another can be the cause of costly trouble. Efficient performance and reduction of down-time are directly related to an electrode's hidden values.

These values grow out of unceasing research that leads to steady product improvement—out of the unwavering control of quality—and out of customer service that renders immediate assistance in overcoming abnormal operating problems.

Such hidden values find further expression in the substantial inventories maintained for customer convenience—in the rapidity of shipment and delivery—and in the integrity of the maker in providing products that can be fully trusted.

These are the values you get in full measure—in addition to the intrinsic merit of the product—when you specify GLC electrodes.

PRODUCTS ELECTRODE GLC DIVISION YOU CAN TRUST®

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N. Y.

HOW WESTERN GEAR SERVES THE STEEL INDUSTRY

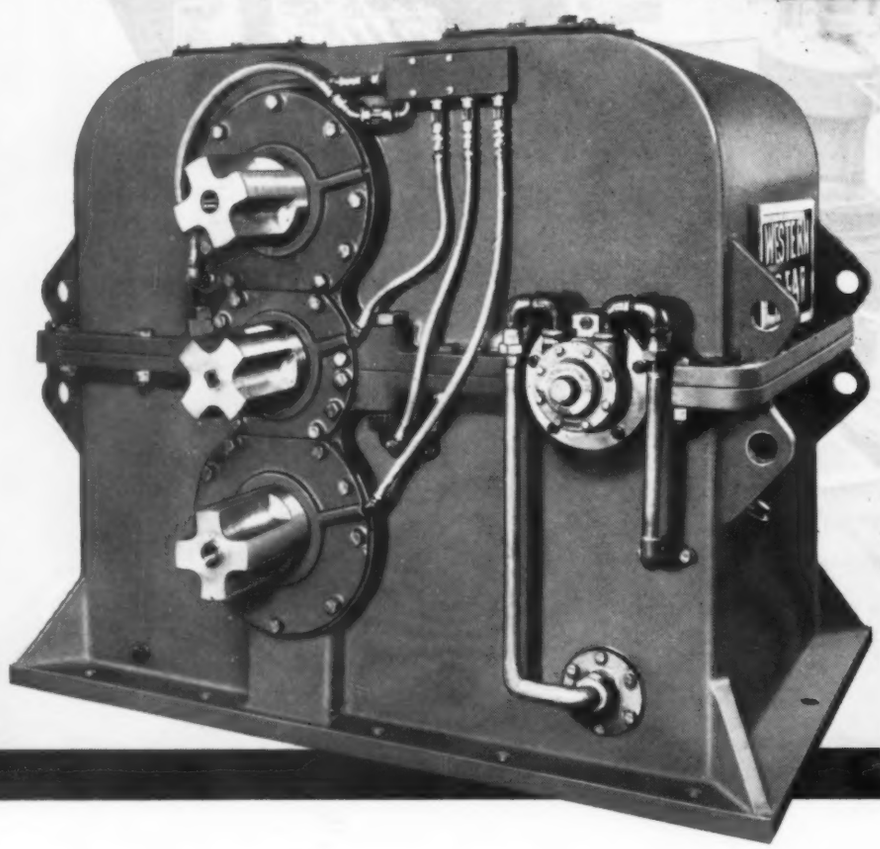
WESTERN GEAR

STEEL MILL EQUIPMENT SAVES YOU MONEY

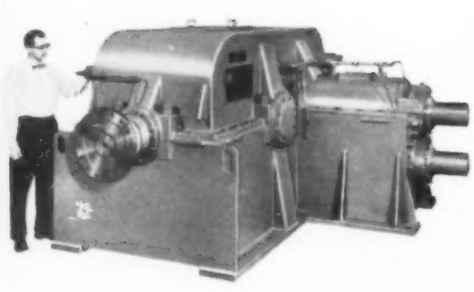
because...on the long run... **QUALITY COSTS YOU LESS!**

From the early days of the steel industry, Western Gear has made continuing studies of the industry's requirements. Today, many major steel mills are equipped with Western Gear speed reducers, pinion stands and combination reducers-pinion stands. ■ Why? Because Western Gear has earned an industry-wide reputation for reliability, and for being able to engineer and deliver the latest in metallurgical developments, tooth design, bearings, and overall rugged construction. ■ Take advantage of this intimate knowledge of America's steel industry. Ask for a Western Gear steel mill application engineer to talk to you about Western Gear's answers to your steel mill needs. For full information ,write, wire or phone collect to: **WESTERN GEAR CORPORATION** Industrial Products Division, P.O. Box 126, Belmont, California • LYtel 3-7611

WG INDUSTRIAL PRODUCTS DIVISION

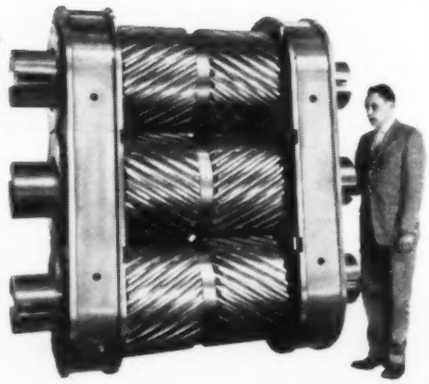


This 3-high pinion stand is combined in one housing with the reduction gears... gives you heavy savings in installation costs and valuable mill floor space. Alloy steel shafts are equipped with anti-friction bearings. Heat treated gears are lubricated by self-contained, circulating oil system. Double helical pinions precision shaved for maximum tooth contact and smoothness of operation. Housing is of heavy, welded, stress-relieved construction.



◀ This 10½ ton integral pinion stand and reducer averages 65% total length as compared to separate units... saves valuable space. First cost lower because fewer parts are involved. Installation costs lower, too, because installation is simpler, faster. Easy to maintain... fewer parts to wear ... large inspection opening simplifies repairs.

Shown here is a 22" center distance 3-high pinion stand ready for placement in the drive housing. Note shaft ends are keyed to allow use of cast wobbler extensions which can easily be replaced when worn out. This is a Western Gear development, designed to meet a specific steel mill customer's requirements. ▶



12 B&W IFB lined single stack annealing covers in use in the strip annealing department of Weirton Steel Company, a division of National Steel Corporation, at Weirton, West Virginia.

uses lightweight B&W Insulating Firebrick for single stack annealing covers.

These 12 covers, lined with B&W K-20 Insulating Firebrick, have been in service more than two years in the annealing of low and high carbon strip from Weirton's 54″ strip mill. Identical in construction, the covers are over 17 feet from base to skew and over 10 feet in diameter. The domes are of 9″ K-20 IFB construction.

The K-20 is one of B&W's *lightweight* Insulating Firebrick. In fact, B&W K-20 IFB are at least a third of a pound lighter than other 2000 F insulating firebrick. This means savings in the overall weight of portable covers. Additional savings in fuel consumption and cycle time are possible because lightweight B&W IFB store and conduct less heat. Heat is kept in the furnace, not in the lining.

This application points out advantages of light weight in insulating firebrick constructions. And B&W makes the *lightest* weight insulating firebrick. Consult your B&W Refractories Representative for information on how you can profit with lightweight B&W IFB.

Bulletin R-2-H available on request.

B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

R-617

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

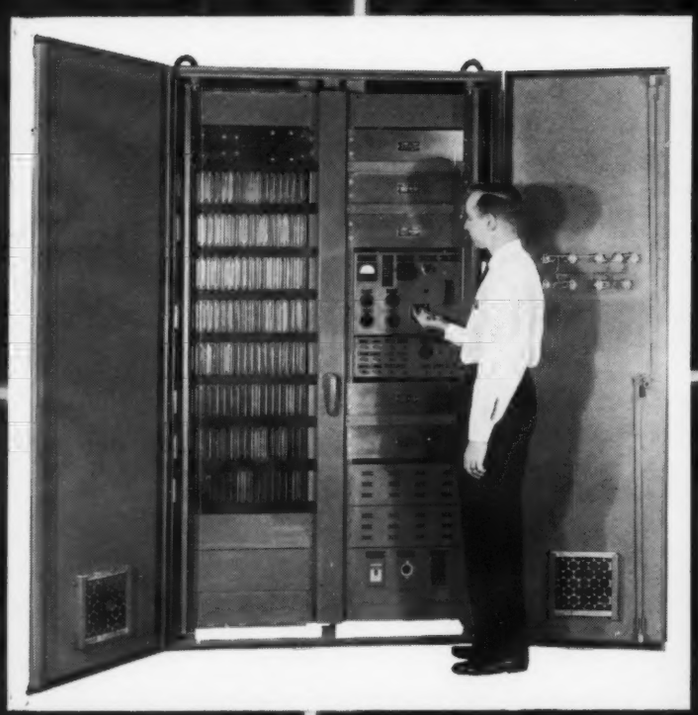
PAYOFF REEL

PROCESS FUNCTIONS

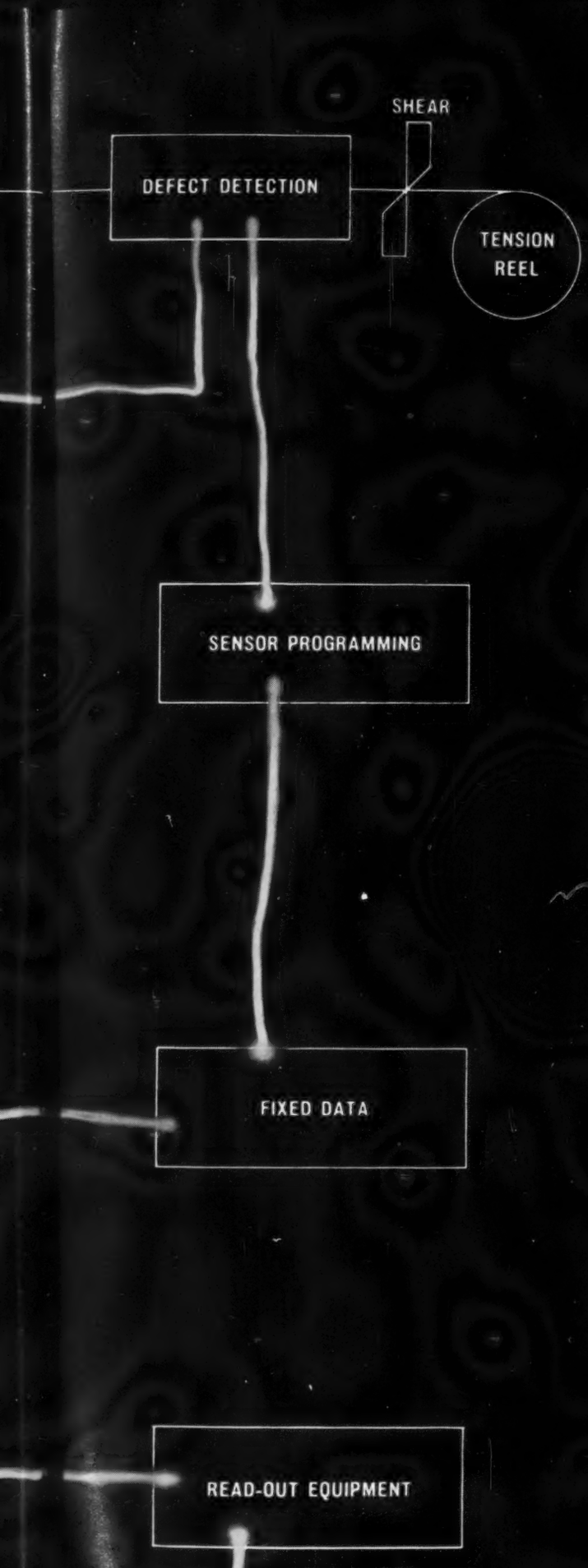
PRODUCTION DATA INPUT

POSITION REFERENCE CO-ORDINATOR

IN-LINE AND OFF-LINE AUTOMATIC MONITORING AND CHECKING EQUIPMENT



READ-OUT SCANNING EQUIPMENT



NEW!

PRODAC DATA ACCUMULATOR IS VITAL LINK IN OPTIMIZING STEEL MILL PRODUCTION . . .

Another Step in Westinghouse Progressive Automation

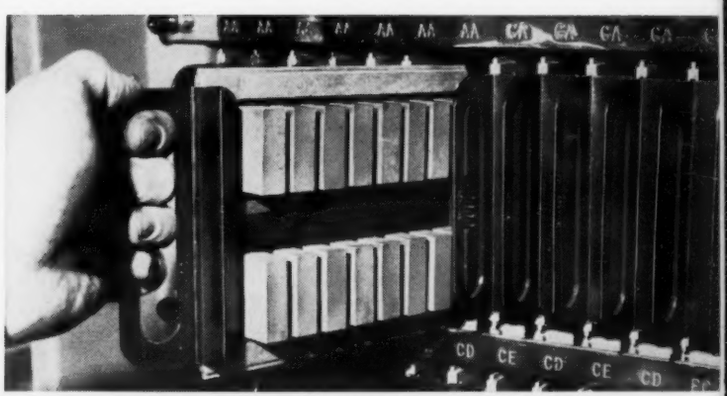
A large eastern steel mill has found that the completely static-design Prodac* Data Accumulator is providing continuous information and read-out of the product quality of its tin mill products. This installation is providing the basic detailed data that is a prime requisite to the ultimate automatic processing line.

Prodac Data Accumulator Systems provide a complete record of the *product itself*. This record is a natural step in *Progressive Automation* of processing lines, rolling mills and other steel-making operations. The Data Accumulator is fully compatible with most sensing devices, electrical controls and read-out equipment.

For counsel-in-depth on steel mill drive systems application, call your Westinghouse sales engineer. He'll show you how you can economically apply step-by-step *Progressive Automation* to boost product quality, cut costs in your plant. For more information about Prodac, call Westinghouse or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-96147

YOU CAN BE SURE...IF IT'S

Westinghouse



This withdrawn module represents a circuit function. It is easily accessible for removal or replacement.

*Trade-Mark

METALGRAMS

UNION CARBIDE METALS

. . . news of "Electromet" ferroalloys and metals

SEPTEMBER 1960

MORE ELECTROLYTIC MANGANESE -- To meet the increasing demand for "Elmang" electrolytic manganese metal, Union Carbide Metals has expanded its cell capacity by 20 per cent. Hence, a larger supply of this high-purity product (99.9 per cent minimum manganese) is assured for additions to steel, copper, and aluminum. Also of interest: (1) The metal is now available in 50-lb. bags for convenient, accurate additions. (2) The 600-lb. drums of "Elmang" manganese are now color-coded to allow easy identification of the regular, dehydrogenated, and nitrogen-bearing grades. Write for new specification sheet, F-20,151.

* * *

ALLOYS FOR BASIC-OXYGEN STEELMAKING -- Interest has been focused on the basic-oxygen process because it can make high-quality steel rapidly and at low cost. Small accurate alloy additions can be made to the ladle of basic-oxygen heats with bagged alloys. Where large chromium and manganese additions are required, "Chromtemp" ferrochrome and "Mantemp" ferromanganese can be added to the ladle. All these unit-weight packages allow precise analysis control. Also, furnace time is not required to dissolve the alloys in steel. Your UCM representative will be glad to give you further details. Also, write for the article, "O_2 Steelmaking," in the Spring issue of UNION CARBIDE METALS REVIEW.

* * *

SILICON IN COPPER -- First developed in France in 1881, silicon bronze is growing rapidly as a corrosion-resistant material for vessels, tubing, marine and poleline hardware, and electrical conduit. Up to 3 per cent silicon provides strength and hardness. For such additions, Union Carbide Metals offers a low-aluminum silicon metal. Since aluminum makes bronze sluggish in pouring, this special grade contains a maximum of 0.10 per cent aluminum. For further information, contact your UCM representative. Also, write for the article, "Silicon Strengthens Copper," in the Winter 1960 issue of UNION CARBIDE METALS REVIEW.

* * *

SERVICE ON THE MOVE -- Every year, experienced metallurgists of UCM's Metallurgical Service Division travel tens of thousands of miles to customers' plants. Their mission: to provide on-the-site help on the use of ferroalloys and alloying metals in melting. As an example, a Metallurgical Service representative worked with Electric Steel Foundry Company of Portland in evaluating the new fast-dissolving "Simplex" ferrochrome in stainless steel. The joint effort showed that 5- to 7-minute savings in furnace time could be made per 2,000 lb. heat. For a picture story of this cooperative service, write for "Service on the Move" in the Winter 1960 issue of UNION CARBIDE METALS REVIEW.

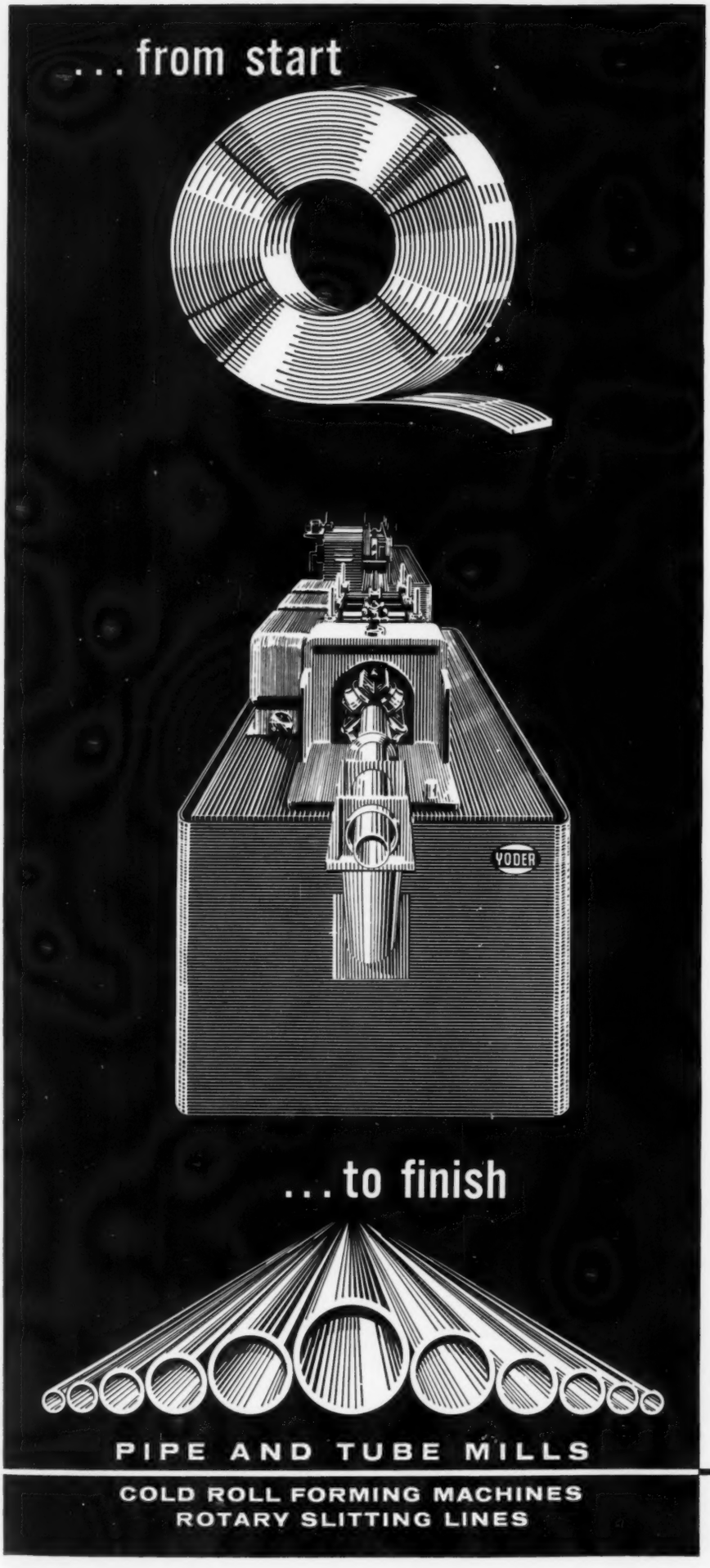
* * *

HIGHER DUCTILITY WITH CALCIUM-SILICON -- Two Midwestern steel foundries recently obtained data on Grade B steel castings made with and without calcium-silicon. In one test of 91 production heats, all of the heats treated with calcium-silicon and aluminum produced castings with satisfactory ductility. As a comparison, over 25 per cent of the heats deoxidized only with aluminum failed to meet reduction-in-area specifications. In another test of 20 production heats, a 15 to 20 per cent improvement in ductility (% RA) was reported. Further data can be obtained by writing for the article, "Calcium Improves Ductility of Steel Castings," in the Summer 1960 issue of UNION CARBIDE METALS REVIEW.

* * *

UNION CARBIDE METALS COMPANY, Division of Union Carbide Corporation, 270 Park Ave., New York 17, N. Y. In Canada: Union Carbide Canada Ltd., Toronto.

"Chromtemp," "Electromet," "Elmang," "Mantemp," "Simplex," and "Union Carbide" are registered trade marks of Union Carbide Corporation.



YODER PIPE & TUBE MILLS

A Yoder engineer can help you realize remarkable savings in the manufacture of ferrous or non-ferrous pipe or tube. He can show you how present Yoder Pipe or Tube Mill owners are increasing production, lowering over-all manufacturing costs and reducing downtime through use of Yoder Mills.

If your products require pipe or tubing from 5/16" to 26" diameters, Yoder Pipe or Tube Mills and accessory equipment can help you produce your product more efficiently to meet today's competitive markets.

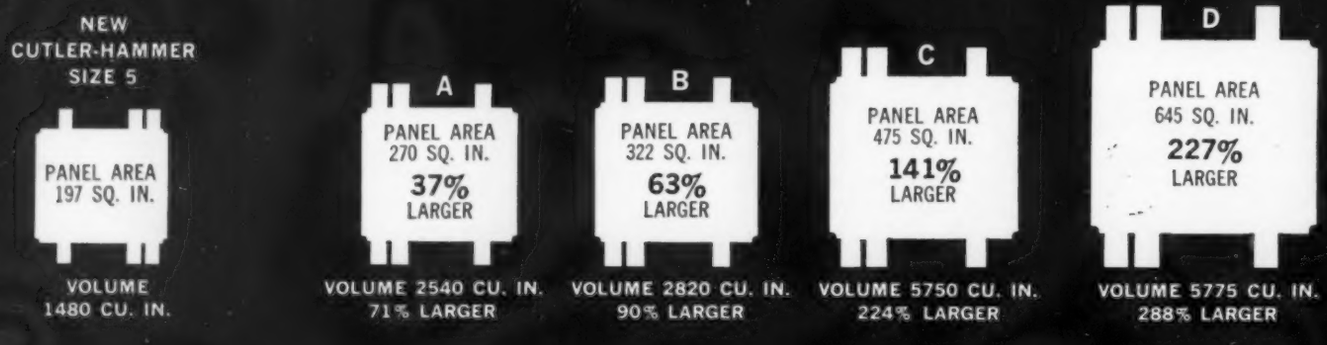
In addition to Pipe or Tube Mills, Yoder engineers and builds a complete line of Slitting equipment and Cold Roll-Forming Machinery.

For complete information on Yoder Tube Mills... send for the fully illustrated, 64 page Yoder Tube Mill book... it is yours for the asking.

THE YODER COMPANY
5495 Walworth Ave. • Cleveland 2, Ohio

ENGINEERING
YODER
MANUFACTURING

THE NEW CUTLER-HAMMER SIZE 5 STARTER IS FAR MORE COMPACT THAN OTHERS



Now! A complete line of easy-to-install Cutler-Hammer Starters including a new compact Size 5

7 sizes for use as components or as complete starters

(Size OO, O, 1, 2, 3, 4 and 5)

Now get all the advantages of Cutler-Hammer's Three Star starter line in seven sizes. You can control motors from fractional hp up to 200 hp, now that the new Size 5 is available.

The new Size 5 starter needs only an eight-inch deep case. Its open dimensions are only 13″ wide, 15 3/16″ high, 7½″ deep . . . and is available as a non-reversing or reversing starter or as a contactor.

Even the wiring's easier. Instead of struggling to force the line and load cables into the lug connectors, the lugs unbolt, and are easily reassembled.

You still get, of course, the famous Three Star advantages that have made Cutler-Hammer Starters so famous: dependable pivoted armature, vertical contacts that don't collect dust, ease of installation, ease of inspection and maintenance, plus many other features.

Be sure to send for Pub. LO-69-S232 to get all the facts on the complete Cutler-Hammer Starter line.

What's New at Cutler-Hammer? There's a new spirit here. You can see it in the new products, the new engineering talent, the increased plant capacities. We're ready for the great growth of the sixties so you can be ready to meet the great demands upon your capacities. We'd like to tell you more. Contact the Cutler-Hammer electrical distributor or the Cutler-Hammer sales office nearest you.

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

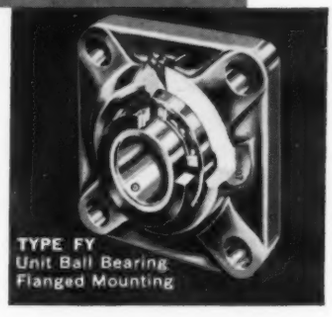
TYPE SAF
Ball or Spherical Roller
Bearing Pillow Block

Can you get these "special" qualities in "standard" pillow blocks?

TYPE SDAF
Heavy-duty
Pillow Block

TYPE SY
Unit Ball Bearing
Pillow Block

TYPE SES
Unit Rubber-flex Ball
Bearing Pillow Block



TYPE FY
Unit Ball Bearing
Flanged Mounting

Most pillow blocks offer easy assembly and rugged housings. But can they offer you low friction, self-aligning bearing operation and efficient sealing as well?

They can—if they're the SKF pillow blocks, and flanged mounting, shown here. Type SAF, for example, comes equipped with low-friction ball or spherical roller bearings that are *inherently* self aligning. And these bearings are effectively protected by Triple-Seal rotating rings. Abrasives and corrosives can't get to them—oil or grease can't drip out.

Yet this is a standard SKF pillow block, that is competitively priced in spite of its combination of extra features. We make it for shaft sizes from ¾" to 10½", for mounting directly or with an adapter. A cast steel housing (SAFS) is available for heavy duty applications.

For details, call one of our twenty-five offices. 5938

Spherical, Cylindrical, Ball, "Tyson" Tapered and REED Miniature Bearings

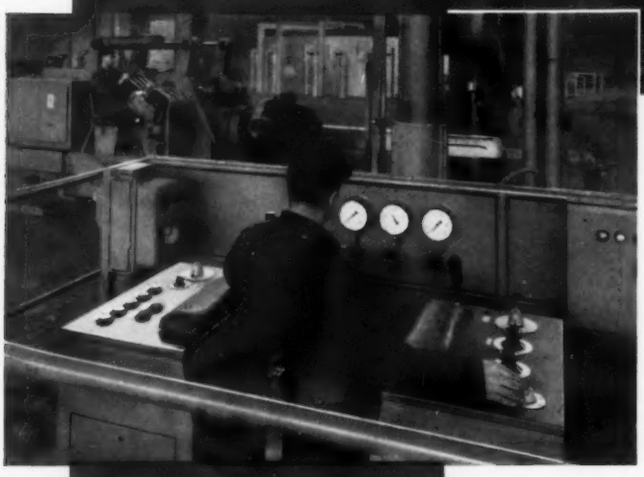
EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

*REG. U.S. PAT. OFF.

SCHLOEMANN



1000-ton High Speed Forging Press of welded construction engaged on automatic planishing. It is also suitable for bending, forging, flattening and levelling duties.

Economic forging

Rigidity combined with ruggedness make for low stresses in the crossheads and columns • Electrically operated oil-hydraulic control system and automatic planishing stroke device with adjustments for length and number of strokes and operating level reduce pressure water consumption and provide for ready adaptability to the requirements of the forging programme • Sensitive control and large number of strokes result in higher forging precision, reducing machining costs and increasing output.

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

From mine through mill, LINK-BELT equipment updates handling

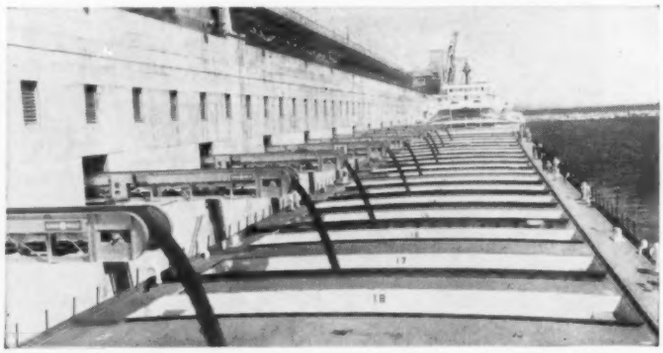
Moves higher tonnages at lowest cost in every phase of steel production

Raw materials must move swiftly and in huge volume to satisfy the enormous needs of the steel-making process. Link-Belt engineered systems take the slack out of steel production by linking the many phases of materials handling into a coordinated, economical operation.

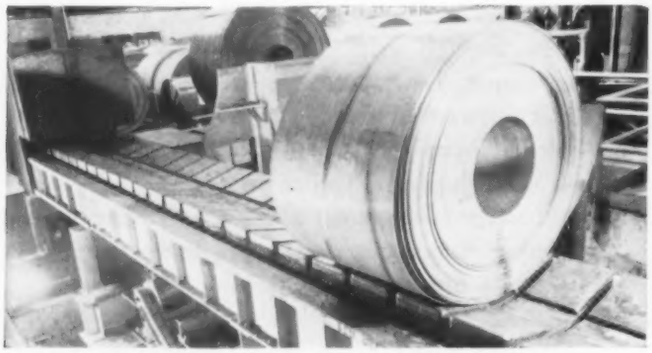
All the way through the mill Link-Belt equipment handles the rough, tough jobs. Conveyor systems move and transfer heavy coils—safely. Chain conveyors transfer white hot billets. Hot slabs, sheets, plate and other items move efficiently from one process to another. Link-Belt engineers will work with your engineers, consultants and builders of mill and process equipment to update your handling procedures. Call your nearby Link-Belt office for information and send for Book 2764. Motion picture available too. Ask to see 16 mm. sound, color film, HANDLING MATERIALS IN THE STEEL INDUSTRY. It shows equipment for handling raw materials and steel coils through various processing operations to final shipment.

WORLD'S LARGEST traveling belt conveyor stacker built by Link-Belt for stockpiling taconite pellets. The huge, self-propelled stacker measures 416-ft. from tip of belt boom to end of counterweight boom. The 275-ft. belt boom stockpiles to a height of 90-ft. Principally for winter operations, the stacker is designed to operate at temperatures of 45 degrees below zero, and winds of 68 mph.

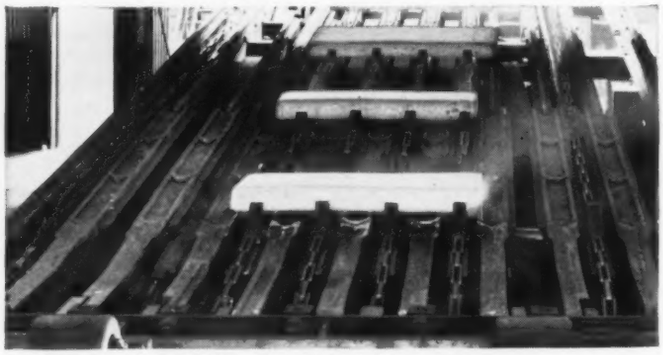
FROM THE MINE—Belt conveyors and traveling belt conveyor stackers stockpile 1000 tons of graded ore per hour. High grade ores are blended with low grade ores to blast furnace requirements. Ore is then shipped to the mills.



TACONITE PELLETS are loaded into Great Lakes steamer by ten Link-Belt shuttle belt conveyors. Two-speed shuttles permit loading at 1500 or 750 g.t.p.h. Conveyors are pushbutton operated by one man in the control tower.



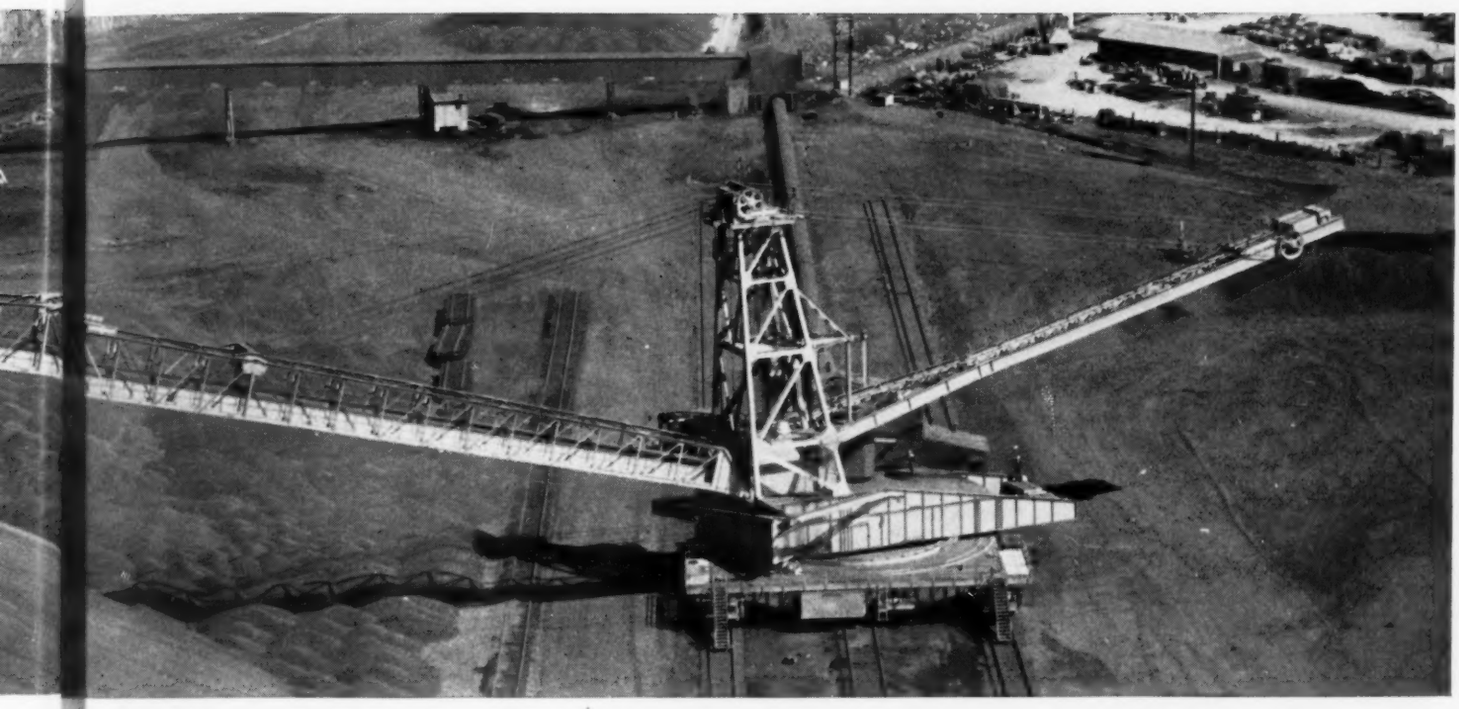
COILS FROM CONTINUOUS PICKLE LINE, ahead of cold rolling mill, move on a V-top, 36-in. wide, heavy-duty pallet conveyor. Each coil weighs 15 tons . . . is carried on its side without scuffing or damage.



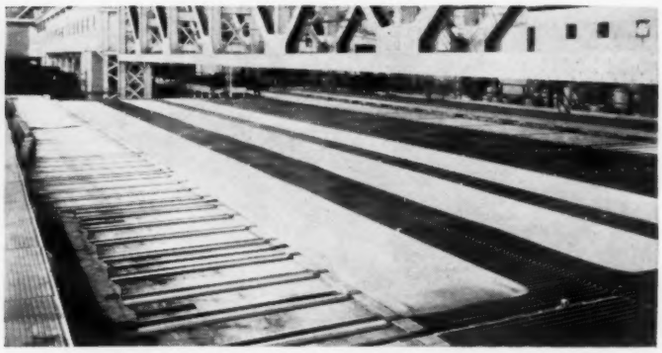
WHITE HOT SLABS are transferred from slabbing mill delivery table to outside storage yard. This heavy-duty, 12-in. pitch, multiple strand chain conveyor assures continuous movement of slabs to match production . . . cooling them in route.

Visit our Exhibit, Iron and Steel Exposition, Public

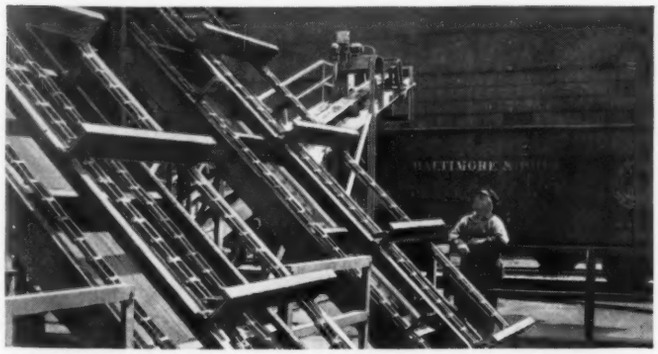
to undercut costs



FROM SHIPS TO STORAGE or screen house—6000 tph belt conveyor keeps raw materials flowing the year around in all kinds of weather. Materials discharge from apron feeder to 60-in. wide, 1260-ft. conveyor on first leg of mile-long trip.



HOT STRIP at this 98-inch hot mill is transferred laterally from run-out table by 51 strands of Link-Belt chain with special pusher dogs. Seventeen strands are used to advance the strip across each of three sections of transfer table.



MILL SCALE is carried off by three Link-Belt Straightline collectors, after it is sluiced from hot strip mill to concentrator. Two Link-Belt conveyors, horizontal collecting belt and inclined pivoted loader carry scale to rail cars.

Auditorium, Cleveland, Sept. 27–30, Spaces 124–125

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

15,252

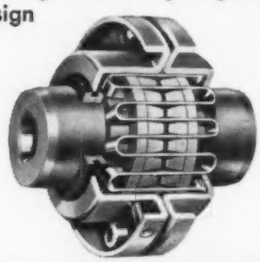
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18″ bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give two-fold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX®
...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. *More than a million* have been bought for industrial service of many kinds.

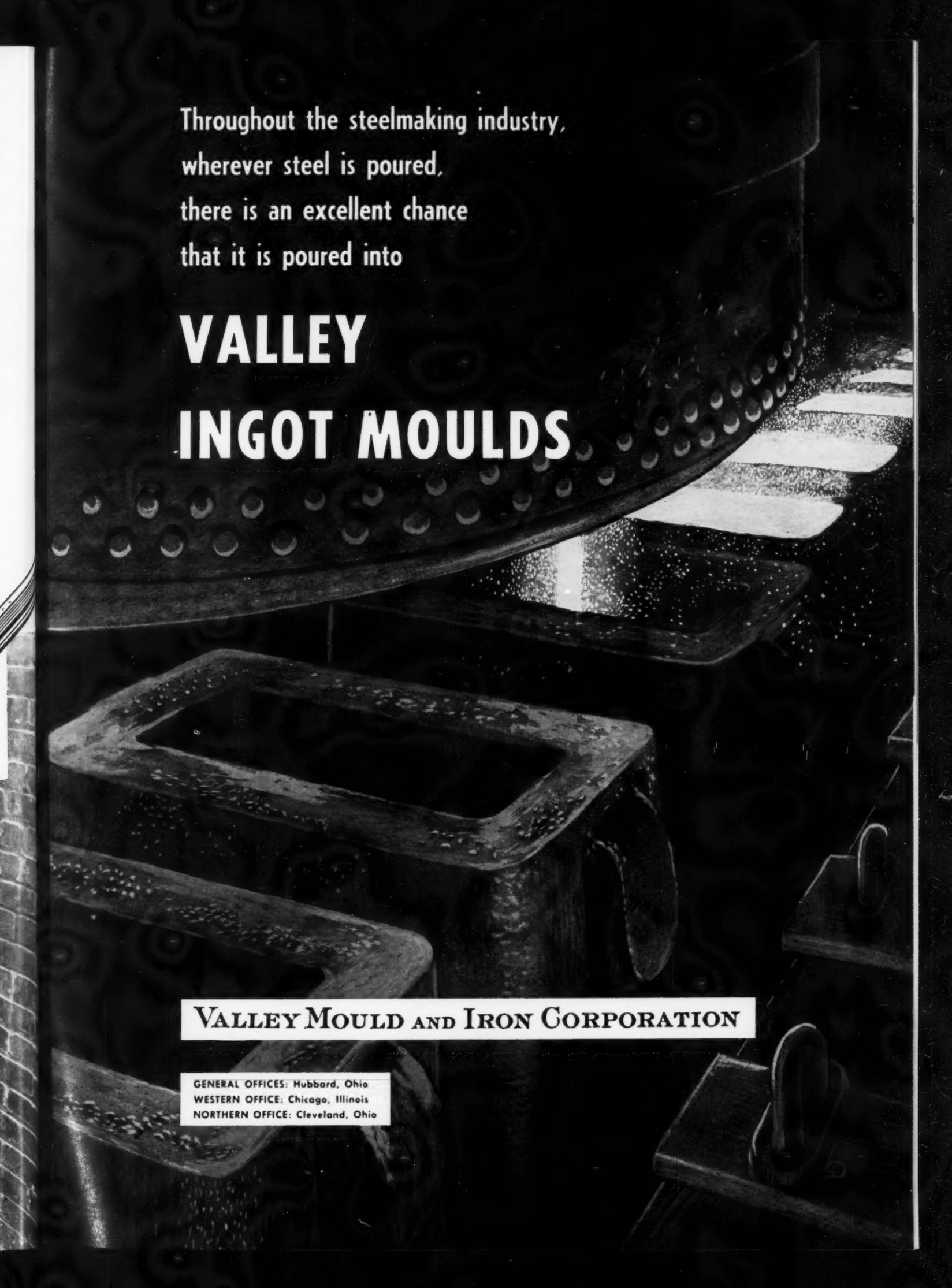
Because, in addition to its inherent superiorities of design, the Type F Steelflex can be used horizontally or vertically without modification or special parts, it has been adopted as standard in many plants—and by many designers and manufacturers of industrial equipment...Write for Bulletin 4100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities

Good couplings not only connect machines; they prolong machine life and boost production!

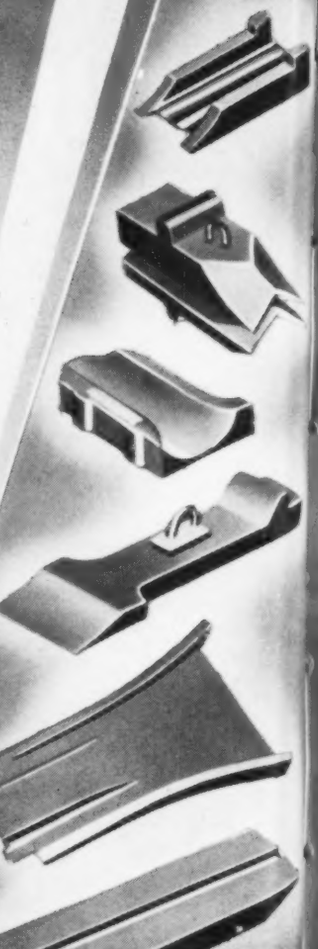

Throughout the steelmaking industry,
wherever steel is poured,
there is an excellent chance
that it is poured into
VALLEY
INGOT MOULDS
VALLEY MOULD AND IRON CORPORATION
GENERAL OFFICES: Hubbard, Ohio
WESTERN OFFICE: Chicago, Illinois
NORTHERN OFFICE: Cleveland, Ohio

TRANTINYL

GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."



ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

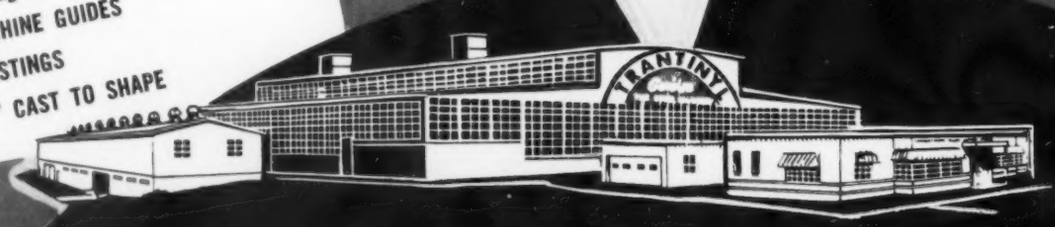
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



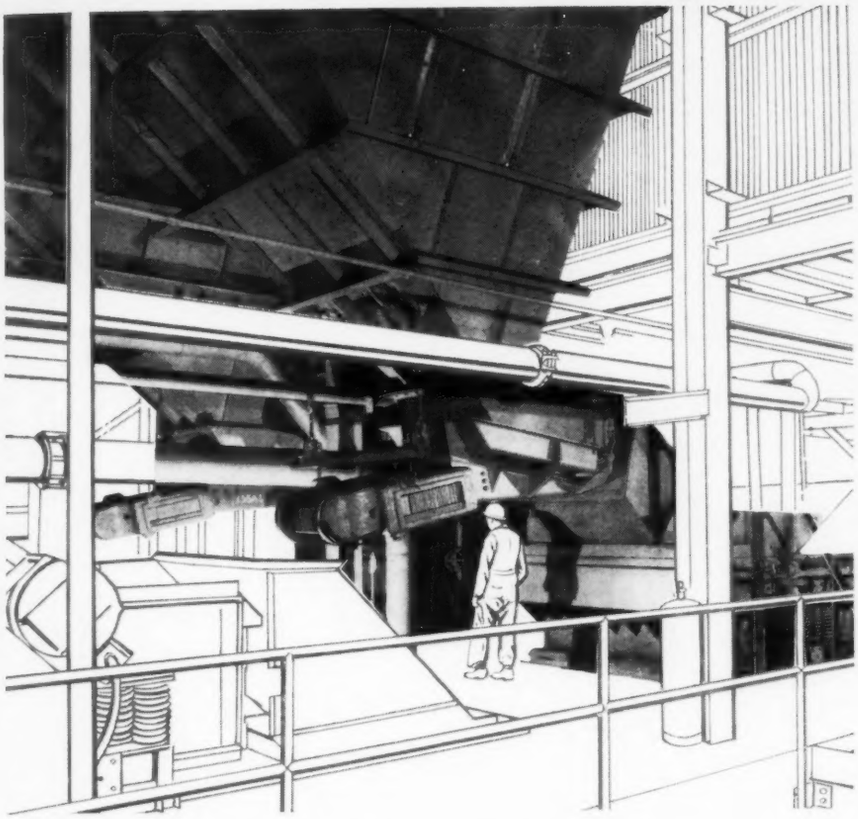
Youngstown Alloy Casting Corporation

Youngstown, Ohio

G-10

SYNTRON cost-cutting equipment of proven dependable Quality

reduces material handling cost



SYNTRON Vibra-Flow

VIBRATORY FEEDERS

. . . .help reduce production costs.

First, by more efficient material handling. They provide a smooth, flow of bulk materials—hot or cold, damp or dry, fine flue dust to big chunks—to processing operations.

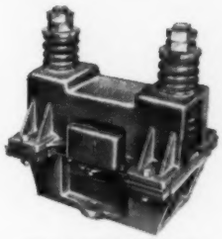
Second, by the instant finger-tip controllability of these feeders. Flow of material can be regulated to match the capacity of operations.

Third, by simplicity of design. The powerful electro-magnetic drive assures long, trouble-free service with very low maintenance cost.

SYNTRON Vibratory Feeders are available in a wide range of sizes and trough styles to meet all your bulk material needs.

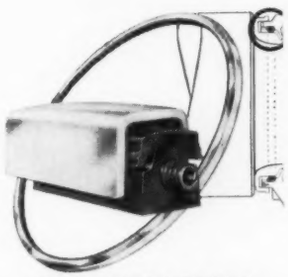
. . . write for informative literature today

Other SYNTRON Equipment of proven dependable Quality



BIN VIBRATORS

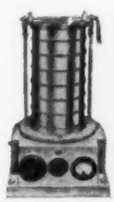
CAR SHAKERS



ROLL NECK SEALS

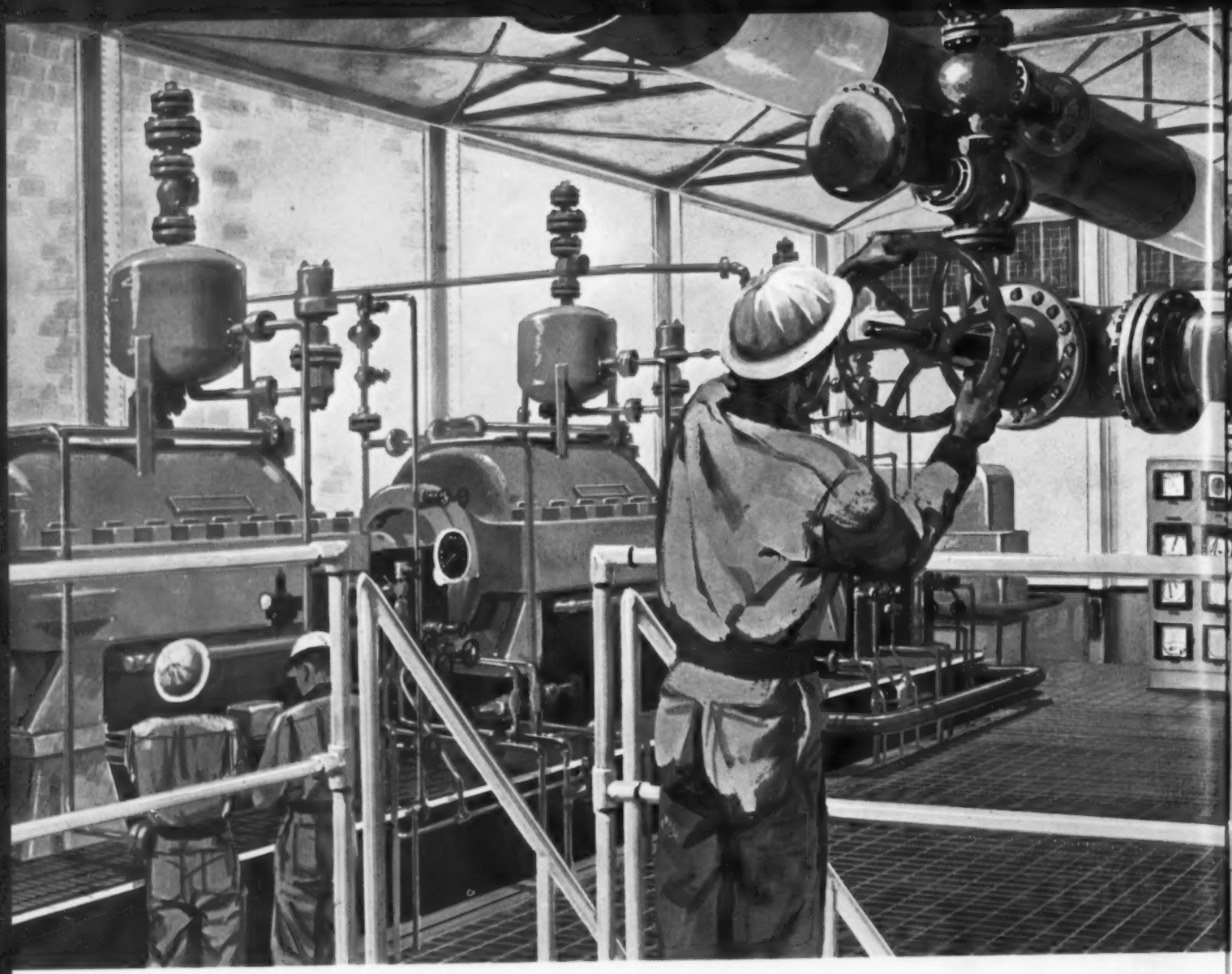
RECTIFIER POWER UNITS

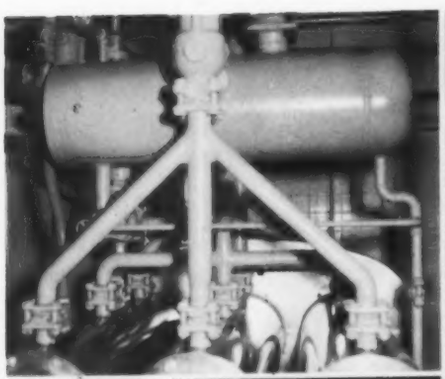
TEST SIEVE SHAKERS



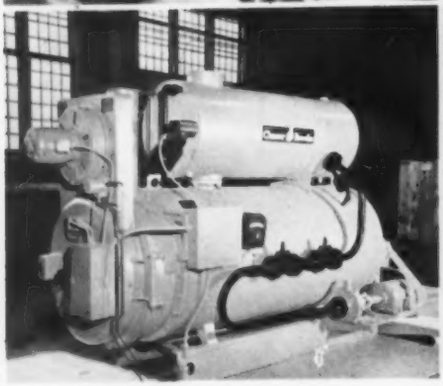
SYNTRON COMPANY

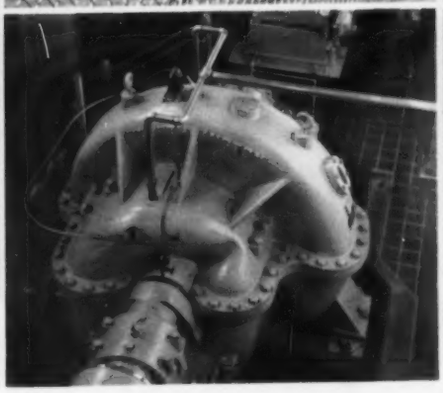
699 Lexington Ave. *Quality Equipment Since 1921* Homer City, Penna.

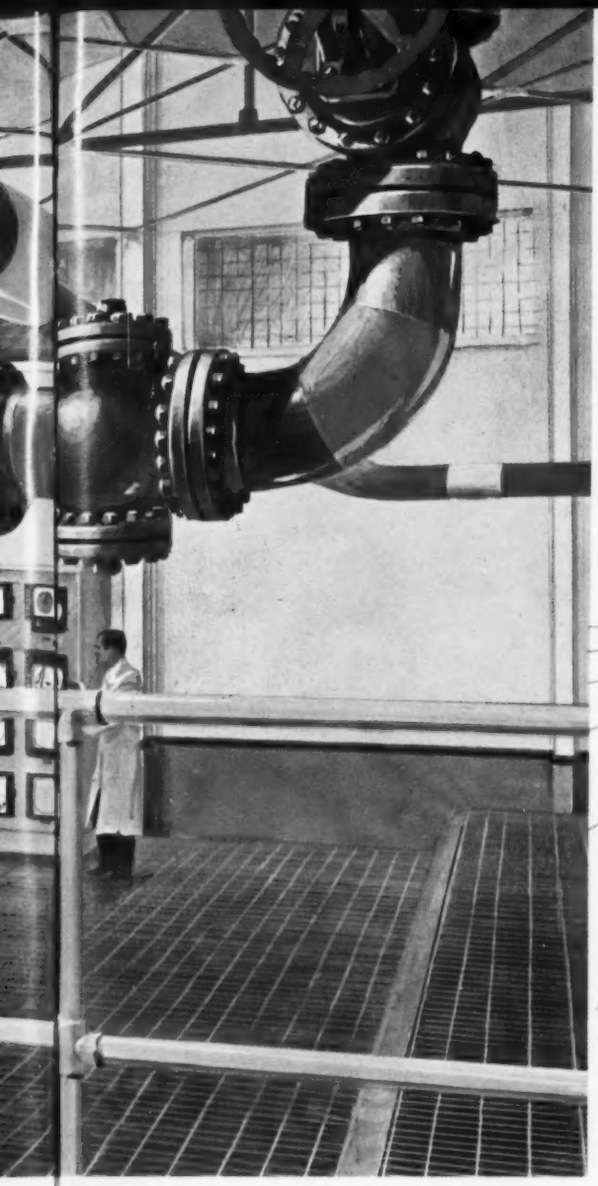




Goodyear







Rust-Oleum

NEW COLOR HORIZONS

System

HERE is a modern, functional *system* that combines four important points. (1) the ability to stop rust, (2) modern color harmony, (3) durability to last and last, (4) ease of application. From machinery, equipment, and structural steel to tanks, steel fences and metal sash – the Rust-Oleum New Color Horizons System can provide lasting beauty in the colors of your choice. Ask your Rust-Oleum Industrial Distributor, together with your Rust-Oleum Factory Specialist, to make a survey of your plant and provide complete recommendations. Rust-Oleum Industrial Distributors maintain complete stocks for prompt delivery in all principal cities of the United States, Canada, and in many countries around the world.

Rust-Oleum, in its various forms, can also save you time and money on problems like these: Heat Resistance, Water Resistance, Chemical Resistance, Coating Galvanized Metal, Speedy-Dry Coatings (less than thirty minutes to dry).

PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

RUST-OLEUM®

See our catalog in Sweet's.

STOP RUST by applying Rust-Oleum 769 Damp-Proof Red Primer directly over the sound rusted surface

Save time, money, and metal. Brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining sound rusted surface after scraping and wirebrushing to remove rust scale and loose rust. **Specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies.

STOPS RUST!®

Distinctive as your own fingerprint. There are imitations, but only one Rust-Oleum.

Insist upon industry-proved Rust-Oleum. Accept no substitute.

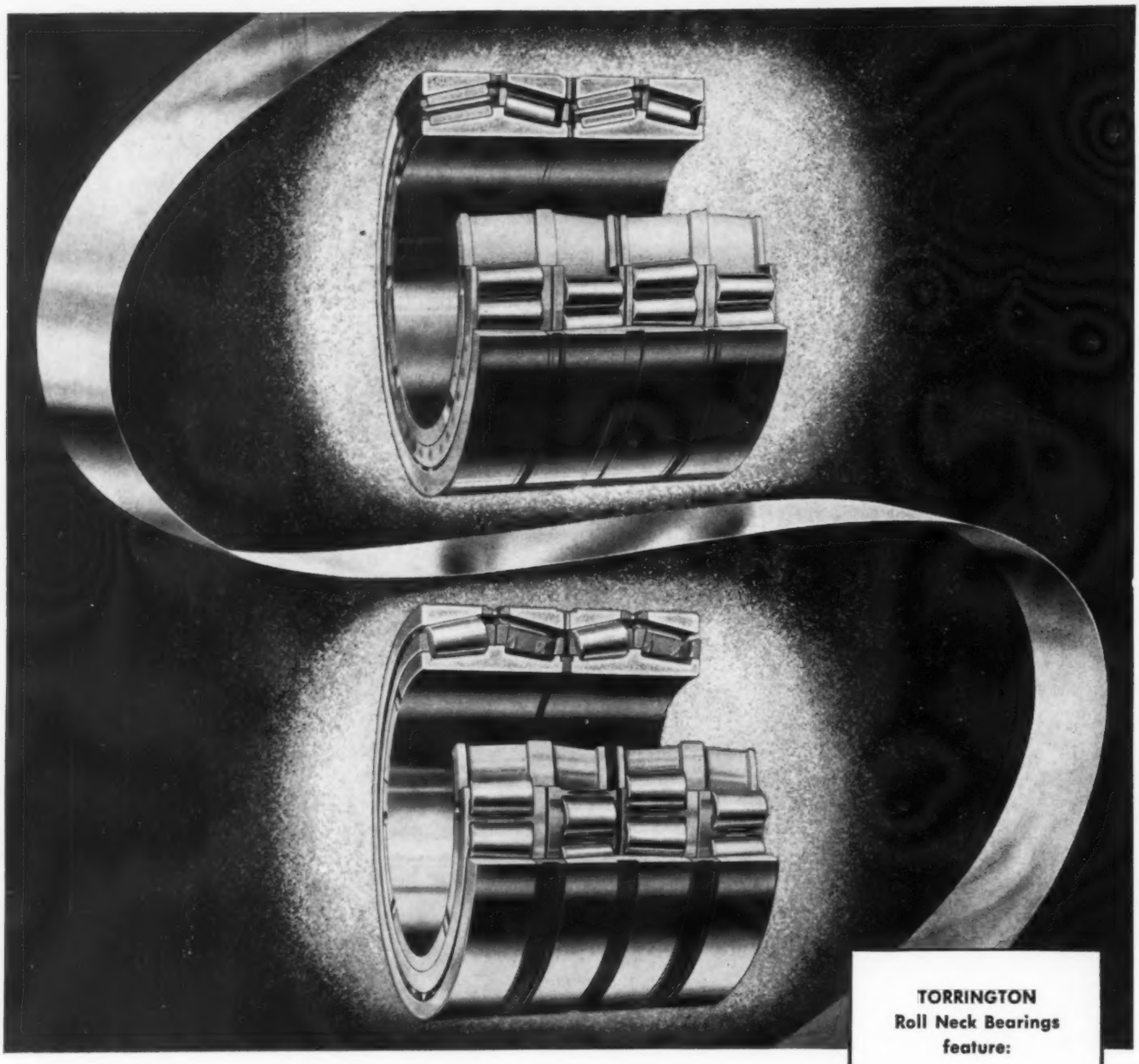
You take the brush! Try a free test sample!

ATTACH TO YOUR LETTERHEAD

RUST-OLEUM CORPORATION
2985 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

- ☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems, including color charts and applications.
- ☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.
- ☐ Please have your representative contact us to discuss a plant survey.



Keep tonnage rolling... with Torrington Roll Neck Bearings

Tonnage rolled per turn and downtime saved—these measure bearing performance in metal rolling mills.

Torrington Roll Neck Bearings are designed for top performance under tough conditions. Maximum capacity and exceptional life expectancy are combined in bearings that operate efficiently under the severest thrust and radial loads. Torrington's advanced heat treating of carburizing-grade steels provides optimum resistance to wear and shock loads. Lubricant grooves on cone faces minimize roll neck galling under creep conditions.

When you choose Torrington Roll Neck Bearings you can be sure they will pay off in more steel production at lower cost. More than a quarter century of experience in anti-friction bearing engineering for metal rolling mills—makes Torrington quality a byword in the industry.

TORRINGTON Roll Neck Bearings feature:

- carburizing grade alloy steels
- advanced heat treatment
- minimum cross section
- high radial and thrust capacity
- resistance to shock loads
- precision manufacture
- grooved cone faces

progress through precision

THE TORRINGTON COMPANY

TORRINGTON BEARINGS

South Bend 21, Indiana • Torrington, Conn.

This New MEAD-MORRISON UNLOADING TOWER

Feeds New England's Only Blast Furnace

The modern Mead-Morrison ship unloading tower shown in the above photo unloads ore for the blast furnace of Eastern Gas and Fuel Associates at their Everett Coke Plant and Blast Furnace in Everett, Mass. Unloading at a maximum rate of 590 tons per hour with straight D.C. control, the tower is responsible for the work of two previous towers which have been dismantled.

Many advanced design and engineering refinements were built into the tower and provide the following advantages:

1. Mead-Morrison's patented single rope progressive reeving system more than triples the life of the grab operating ropes and greatly reduces the man hours required to remove worn out rope.

2. Automatic dumping of the grab bucket decreases operator fatigue and assures that the bucket will always dump at the same point. All motions of the grab bucket to the rear of the front columns are performed automatically.

3. Mead-Morrison's patented hinge alignment devices greatly reduce maintenance on the two Mead-Morrison grab buckets furnished for the tower.

4. Mead-Morrison's dead-man control stand provides control of all bucket motions with two simple latched levers.

5. A safety device eliminates collision between the tower and the apron of the Mead-Morrison ore bridge serving the ore stockpile.

6. Mead-Morrison's patented automatic, self-adjusting rail clamps provide positive protection against movement in high winds.

7. An extendable operator's cab permits good visibility into the holds of the ship.

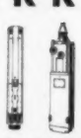
Your next installation can have these advantages. Address your inquiries to:

MANUFACTURING ENGINEERS • McK • ESTABLISHED 1895

McKIERNAN-TERRY CORPORATION

ORE BRIDGES

RAIL CLAMPS


PILE HAMMERS

CAR DUMPERS

GRAB BUCKETS

CAR HAULS

MEAD-MORRISON DIVISION • HARRISON, NEW JERSEY

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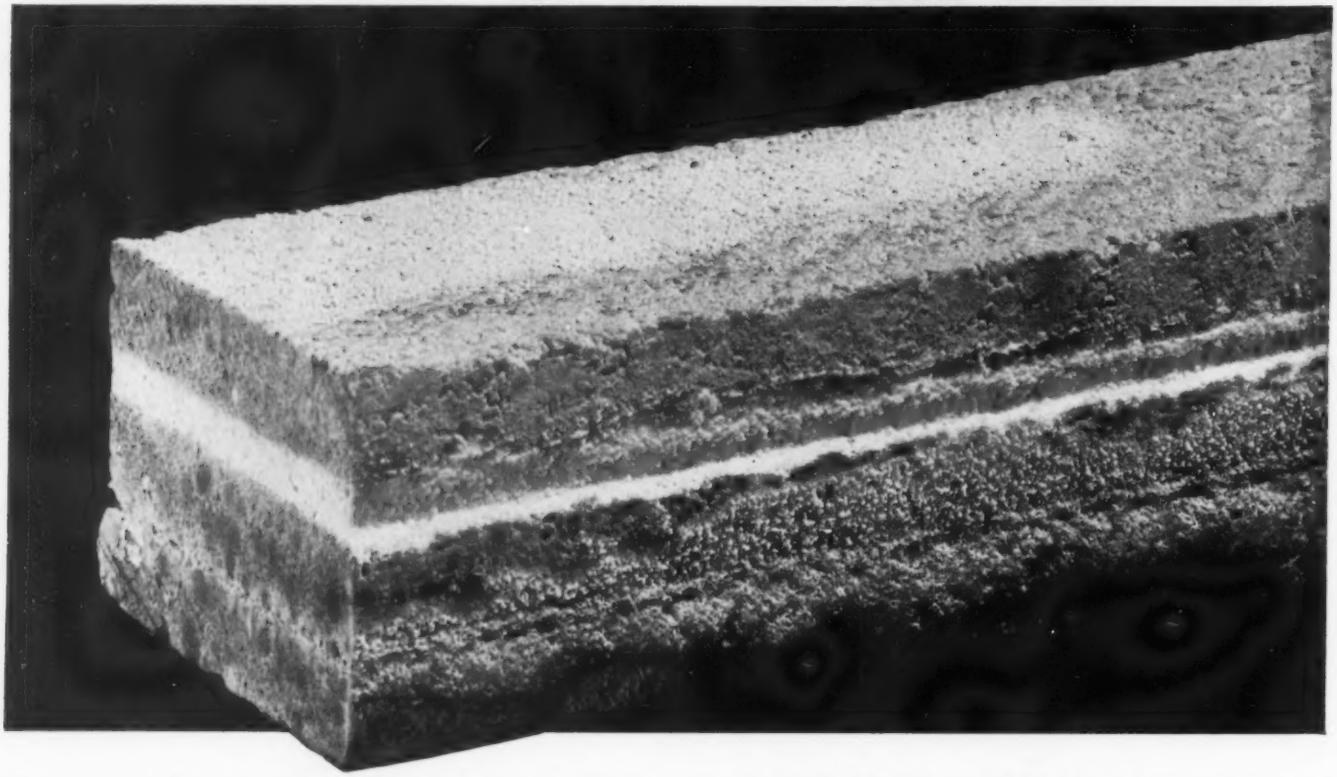
TRIAL BY HEAT...



Superior Refractoriness of TASIL 301 Cement proved by severe test

TEST DETAILS...

Three slices of TAMUL brick were cemented together with approximately ¼" thick joints—one of TASIL 301 Cement, the other a widely used fire clay base high temperature cement. After drying, an 11-lb. brick was placed on top of the specimen which was then put in a laboratory re-heat furnace. The specimen was fired to 3000° for five hours, then allowed to cool. The brick was then sectioned, as shown.

Get TASIL Special Refractory Cements in the form you prefer:

No. 301 Air-Setting Cement—ready-mixed in drums.

No. 317 Air-Setting Cement—dry in bags.

No. 302 Heat-Setting Cement—dry in bags.

After five hours at 3000° temperature, the TASIL mortar in this test "sandwich" was unaffected. In the other joint, the cement has melted and run out—permitting the brick to press completely together.

New improved TASIL 301 Cement was developed to pass these specifications:

- **Superior refractoriness . . . high bonding strength . . . improved workability . . . minimum shrinkage at high temperatures . . . maximum resistance to slagging and erosion.**

Get maximum joint protection by using TASIL 301 Cement for your next furnace rebuild.

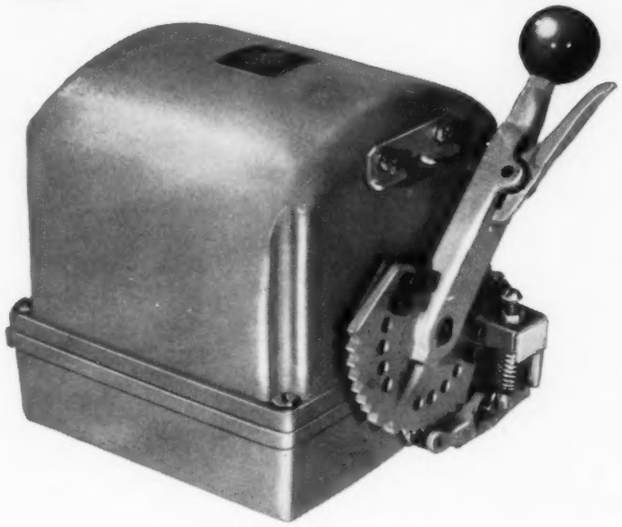
Call in your Taylor Field Engineer, or write direct for details.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Oakville, Ont., and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.

REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

MILL-DUTY ACCESSORIES



MASTER SWITCHES

Heavy-duty design offers long life, high reliability

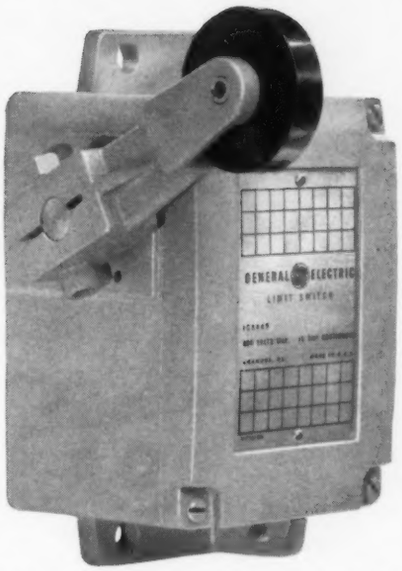
Self-lubricating phenolic cams—impregnated with graphite—keep General Electric master switches performing longer . . . even in the toughest conditions. Numerous mill installations show that these cams—coupled with steel cam followers—will operate millions of times without replacement.

Modern design of the G-E master switch permits quick modification—with a minimum of parts—to perform different sequences. And, cams can be interchanged without disassembling the switch. Offered in surface- or deck-mounted models, these switches are 25% smaller than other designs.

Check these "extra-value" features of General Electric master switches:

- **Entire switch unit** lifts out of enclosure for ease of wiring and mounting.
- **Pawl arrangement** allows for convenient adjustment to each operator's "feel."
- **Adjustable stops** give maximum of seven points in each direction, plus off.

Want more information? See your G-E Sales Engineer; or write Sect. 784-28, General Electric Co., Schenectady, N. Y. for Bulletin GEA-6706. *Industry Control Dept., Salem, Va.*



LEVER LIMIT SWITCHES

New adjustable cams permit fast, on-the-job adaptation

Here is a new lever-operated limit switch that lets you adapt it to the application . . . right on the job. You no longer need to predetermine circuit requirements before selecting a device. This means fast installation or quick adaptation when requirements change. A new system of adjustable cams on General Electric's lever limit switch makes this flexibility possible. A template—provided with every switch—guides changing the cams.

Lighter and more compact, General Electric limit switches are available for either two- or four-circuit operation . . . and, in a wide choice of enclosures.

Consider these key features of the new General Electric lever limit switch:

- **Readily-accessible contact blocks** are of unit construction, easy to wire.
- **Variety of levers** offers wide selection to meet your specific application.
- **Starwheel** may be set for either maintained or spring-return operation.

For the complete story, see your General Electric Apparatus Sales Engineer, or write Section 784-28, Schenectady, N. Y. for Bulletin GEA-7203. *Industry Control Dept., Salem, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

ILLINOIS SETS THE PACE IN *BIG*

★ Here is progress-in-action to meet the fast-moving, ever-changing requirements for large gears in industry.

ILLINOIS GEAR has been meeting this challenge by constantly adding new, modern production facilities . . . the latest of which is the equipment illustrated here. It is the *newest, largest and most modern of its kind in the world.*

Spectacularly large, this precision gear cutting, hardening and testing equipment will handle spiral, Zerol and hypoid bevel gears up to 94″ pitch diameter, 13″ maximum face, .625 D.P. (5½″ C.P.) 2.875″ tooth depth and hypoid pinions to 10″ offset.

These large precision gears offer new possibilities that may well open new horizons in the design of your equipment. Ask for full information today.

SPIRAL BEVEL GEARS

ZEROL BEVEL GEARS

HYPOID BEVEL GEARS

up to 94" diameter and 13" face

Look for this mark ILLG® *the symbol on finer gears*

ILLINOIS GEARS Reg. U.S. Pat. Off.

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

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ELPAR'S New TITAN

. . . first BIG TRUCK with small truck maneuverability

No other truck in the 12,000 to 20,000 lb. capacity range can match the new TITAN for maneuverability. Built to operate through box car doors, the TITAN is ideal for car loading and for handling in narrow or congested aisles.

Other important features include:

TRI-SAFE BRAKING—an ELPAR safety exclusive that provides three independent braking systems operated by a single toe bar.

FASTER SPEEDS — fast lift and travel speeds plus rapid acceleration mean greater working efficiency.

UNEXCELLED VISION—elimination of bulky linkage gives the operator a clear view between the uprights.

As easy to operate as the family car, the new TITAN is the product of ELPAR's more than 50 years of industrial truck building experience. Compare features and you'll be convinced the TITAN is the best heavy duty fork truck buy!

5 models — 12,000 to 20,000 lbs. capacity

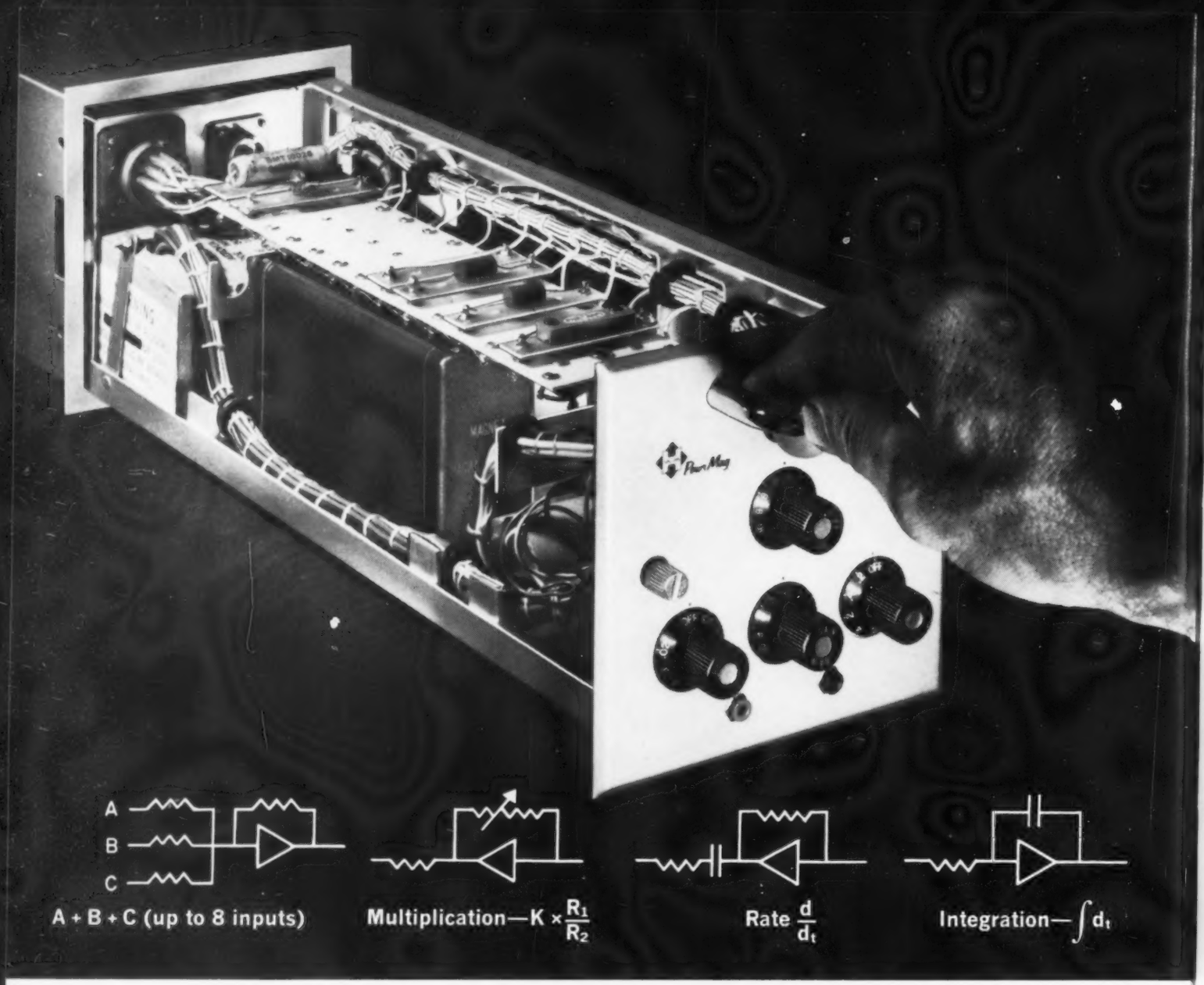
Send for this new TITAN folder —

ELPAR

THE **ELWELL-PARKER** ELECTRIC COMPANY
4549 ST. CLAIR AVENUE • CLEVELAND 3, OHIO
In Canada: International Equipment Company, Ltd.

ELECTRIC TRUCKS

TWICE THE LIFE . . . ONE-THIRD THE OPERATING COST



MAGNETICALLY—ONE CONTROLLER for all control functions

Hagan's PowrMag controller combines the kind of reliability required by industry with a flexibility of application that makes this one controller suitable for all control actions. Utilizing a high gain, operational magnetic amplifier, PowrMag can produce the full range of control actions by simple negative feedback through ordinary resistors or capacitors. These "passive network" elements are simply and easily plugged into the basic amplifier chassis by means of an integral plug-board, as shown in the photograph.

Here are some of the characteristics that make the PowrMag so valuable to a control system designer . . . Control signals—1 to 9 v DC *(no noise, capacitive loss or phase shift problems)*—Entire amplifier potted and then encased in steel *(virtually unaffected by environment)* — Utilizes unregulated 110 v AC power supply *(uses only 3 watts of power)* —Full integration action from a minimum change *(high sensitivity)* —Modular construction *(no inventory problems—each unit can perform any given function by a simple change of plug-in components)* — Each module is equipped with a pilot light to indicate fuse failure, test jacks to plug in an output meter, calibrated knobs for set point (bias), gain, reset and rate. Components can be replaced without a soldering operation *(minimum maintenance)*.

The Hagan PowrMag line includes the controller, remote control stations, patchboards for interconnecting the system, sensing elements and final operators. Why not phone or write for a Hagan engineer to give you all the facts on this remarkable system.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"MATERIALS BALANCE AND HEAT BALANCE IN THE LD BASIC OXYGEN TOP-BLOWING PROCESS"

by J. MAATSCH, E. PLOCKINGER and M. WAHLSTER, Fried. Krupp, Essen, Germany. (Translation No. 4808 from Technische Mitteilungen Krupp, Vol. 17, No. 6)

△ THE importance that some of the oxygen steelmaking processes have currently attained in the industry is due in large measure to their favorable materials and heat balances, as compared with open-hearth and converter processes. Common to all refining processes that use technically pure oxygen is their independence of any outside heat source and their low heat losses, thus, in principle, making it possible to use pig iron of almost any composition. The excess heat from the refining reactions can be utilized for melting scrap or for reducing ores. Partial combustion of the refining gas to carbon dioxide in the reaction zones makes it possible to work in still more scrap or ore, thus improving the commercial aspects of the process.

Materials and heat balances have been calculated for a 3-ton LD heat cooled by scrap, at intervals throughout the process. The results of this representative example provide interesting insights into the reaction phenomena and the amounts of heat produced and consumed in the course of the process. From these balances it is apparent that any displacement of a reaction with respect to time, or any change in the amounts of material undergoing reactions, such as the use of a different type of pig iron or additions, will result in a change in shape of the heat excess curve. This will mean an alteration of the temperature pattern for the melt, with consequent marked effect on all the metallurgical reactions involved.

About 22 per cent of the heat evolved in the refining process is unavoidably lost to the metallurgical reactions by way of the waste-gas and through radiation. The additional 18 per cent heat absorbed by the refractory lining of the experimental furnace can, in a large part, be utilized in continuous commercial operation. On the other hand, there is only a limited possibility of supplying heat to the bath by supplemental combustion of carbon monoxide in the gas space.

A check of the calculated results against data from independent sources and the use of different computational methods confirms the accuracy of the experimental results.

"RESULTS OF AN INDUSTRIAL TRIAL WITH FERROCOKE (IN BLAST FURNACE)"

by H. LINDE, K. SCHWINDT and M. PASCHKE. (Abridged translation No. 4069 from Stahl und Eisen, Vol. 75, No. 11)

△ REPORT on a trial run of a medium-sized German blast furnace on ferrocoke. Data on blast furnace and on production and iron content of ferrocoke used in trial. Variation of CaO/SiO_2 ratio of slag and the pig iron composition in course of trial. Coke rate and top gas production during trial run. Dry coke rate with ordinary coke and ferrocoke according to experimental data.

It was shown advantageous to use coke prepared from a mixture of gas coal and suitable ore fines. Using ferrocoke with 16 per cent iron the coke consumption can, with suitable running of the furnace, be kept about 6 per cent lower than with normal coke.

"STUDY OF AUTOMATIC CONTROL SYSTEMS FOR STEELMAKING ARC FURNACES"

by A. I. SAPKO, Dnepropetrovsk Metallurgical Institute. (Translation No. 4630 from Izv. Vuz-Chern. Metallurgiya, January 1959)

△ ELECTRIC arc steelmaking furnaces require large amounts of electric power and any improvement of their efficiency saves considerable electrical energy.

Several systems used for automatic control, with their advantages and defects, are surveyed in this article.

In designing or studying systems of automatic control, it is necessary to take into account the effect of design defects in positioning mechanisms on the quality of control, since controller, positioning mechanism and controlled plant constitute a single kinetic control system.

Replacement of an inferior electric circuit of a controller by a better, but more complicated one, without real improvement in the design of the positioning element does not improve the control quality, but only complicates the servicing and increases the number of breakdowns in service.

In improving and designing positioning mechanisms, it is necessary to strive after rigid connections between motor and electrode holder, and to increase the efficiency of the mechanism so as to reduce the power of the motor, which improves the quality of control. In this respect the development and introduction into our steel-melting arc furnaces of electrohydraulic positioning mechanisms, and of high-sensitivity and high-speed systems of hydraulic control is of great practical interest.

The electrohydraulic system of electrode positioning gives a higher-quality control than an electromechanical drive when associated with an electric-machine controller (no lag, high sensitivity, high speed and stability in operation of the automatic control system).

OTHER AVAILABLE TRANSLATIONS

"Vacuum Treatment Of Liquid Steel And Ferroalloys In Ladle And Mold—A Discussion," by S. G. Vysotin, S. P. Samotaev, Yu. A. Shul'te, and N. Ya. Neimark, a collection of papers entitled *Use of Vacuum in Metallurgy*, USSR Academy of Sciences Press, Moscow, 1958. Drawbacks inherent to vacuum treatment of steel in ladles: their elimination by an improved setup where the steel is degassed by holding it for four to five minutes in a vacuum vessel at 50 mm Hg and then pouring it into molds.

Experience with forging ingots of up to 30 tons, vacuum treated in various ways at 7 mm Hg before pouring, and then compared with ingots not vacuum treated. Usefulness of vacuum treatment in ladle for increasing electric furnace production by halving the time of the boil; economic importance of preventing reoxidation of steel during pouring. Production of compact low-carbon and carbon-free ferrochromes by blowing heats with carbon dioxide and then vacuum treating them in ladles. (Translation No. 4374)

"Continuous Casting Of Steel Into Square-Section Billets," by V. S. Rutes and N. A. Nikolaev, Central Research Institute for Ferrous Metallurgy, Metallurg, October, 1958. Experience in pilot-scale continuous casting of 8-in. square billets of steel (carbon, tool, low alloy). Design details: pouring platform; upper and lower pinch rolls; tilting cradle; tundish; two-strand mold; secondary cooling system. Movement and lubrication of mold. Recommended casting speed for medium-carbon steel: time required for complete freezing of an 8-in. square billet; calculated depth of crater of liquid metal; best level for placing the first group of pinch rolls. Incorporation of lessons learned into design of new continuous casting plants, in part already building in the Soviet Union. (Translation No. 4425)

"The World's Biggest Continuous Casting Plant For Steel," by V. V. Ful'makht, E. M. Kan and A. F. Chumichev, Central Research Institute for Ferrous Metallurgy, Metallurg, June, 1958. Description of the four-strand, completely automated continuous-casting plant installed at the Stalinsk Iron and Steel Works, Kuznetsk, Siberia. Design and operating details of the new plant. (Translation No. 4343)

"Waste Heat Recovery At The LD Steelworks In Donawitz (Austria)," by A. Vacek, Berg-und Hüttenmännische Monatshefte, vol. 104, 1959, No. 2. Outline of situation of LD oxygen converter process when Austrian authorities at first refused to permit operations unless the brown fumes were eliminated. Tabular data on preliminary experiments on cleaning the flue gases wet or dry. Progress made with waste heat recovery at Donawitz works (in conjunction with electrostatic dust precipitation). Principle of Lamont boiler used to bring temperature of outgoing gases from 3270 F to about 570 F. Heat recovery by steam production. How the plant's two steam systems, operating at 12 and 50 atm, are fed. Adaptability of systems to prevailing operating conditions. Turbine output related to sequence of LD blows. (Translation No. 4644)

"Dust Removal Plant At The Bochumer Verein LD Steelworks," by R. Harr, K. Wagner and T-H. Willmer, Berg-und Hüttenmänn. Monatshefte, vol. 104, 1959, No. 2. Equipment selected for gas cleaning at the new steel works of Bochumer Verein, consisting of two 35-ton LD vessels and one 75-ton arc furnace, where the outgoing waste gases were to be freed from any visual color without contamination of surface or subterranean water supplies. Cooling and removing the dust from LD waste gases. Treatment of sludge and recirculation of cooling water. Conditions to be met for efficiency of dust removal; dust particles in the cleaned gas. Cost data on waste-gas cleaning. (Translation No. 4646)

"Fundamental Japanese Work On The Structure And Properties Of Hot-Dipped Aluminum Coatings," by D. Horstmann, Stahl und Eisen, vol. 79, 1959, No. 25. Highlights of recent Japanese work on various problems arising in hot-dip aluminizing of steel. Black spots on sheet dip-coated with aluminum: effect of various fluxes, oil residues and iron oxides on their occurrence and ways of minimizing them. Effect of sheet thickness on growth of iron-aluminum alloy layer; and of preceding heating of sheet in a flux bath on thickness of alloy layer, with various sheet thicknesses. Nature and thickness of alloy layer as function of preceding cold reduction of steel and of speed of withdrawal from aluminizing and the latter's temperature. Effect of minor elements present in the aluminizing bath or in steel being coated on thickness and hardness of alloy layer. Behavior of aluminum coatings in subsequent shaping operations; air vs water cooling from aluminizing temperature. (Translation No. 4733)

"Wear Of Refractories In Different Zones Of The Blast Furnace," by O. M. Margulis and E. A. Gin'yar, Refractories Institute, Kharkov, Ogneupory, vol. 22, No. 12. Report on linings of five blown out Russian blast furnaces, in part operated on oxygen-enriched blast, and lessons learned from findings as to possibilities of ensuring longer lining lives. Data on composition and properties of brick used in the different furnace zones. Action of alkalis and alkaline-earth oxides. Cooling of hearth bottoms. Recommendations. (Translation No. 4643)

Another example of National Roll quality control

Deac Scholl, sales manager at National, discusses steel roll machining with Joe Rebar, right, roll shop superintendent.

Contour machining gives more precise shaped rolls

Some of the most impressive equipment installed in National's roll shop are the large contour lathes. Some of the largest ever made, these lathes faithfully follow the lines of carefully made templates in machining grooved steel rolls for the shaping of steel beams, rails and a multitude of other end products.

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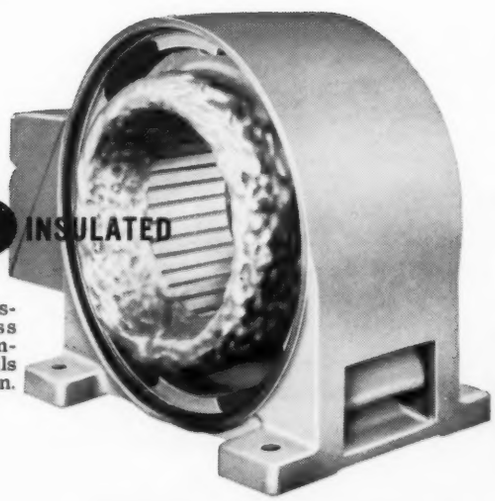

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WO-2

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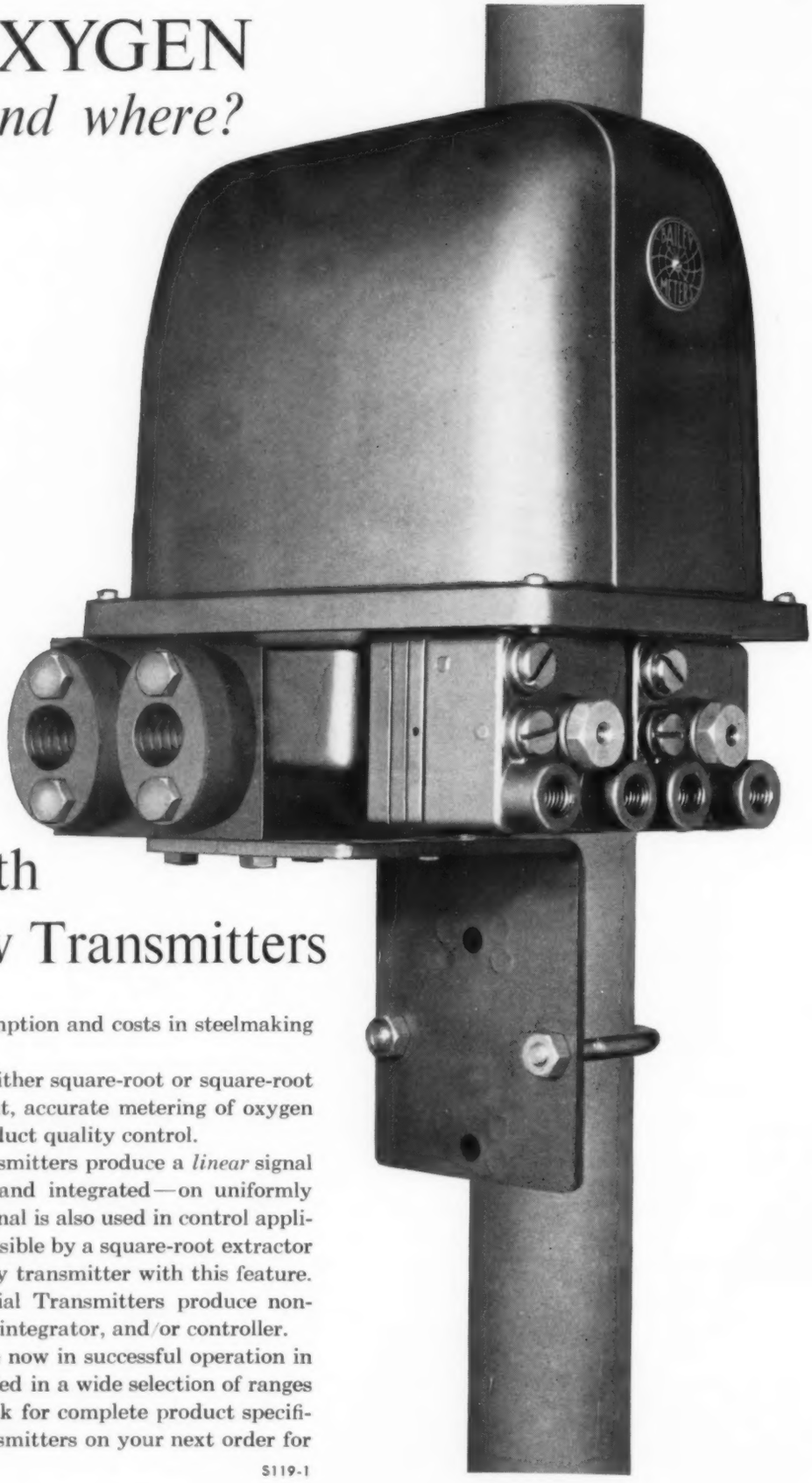

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IRON AND STEEL DIVISION

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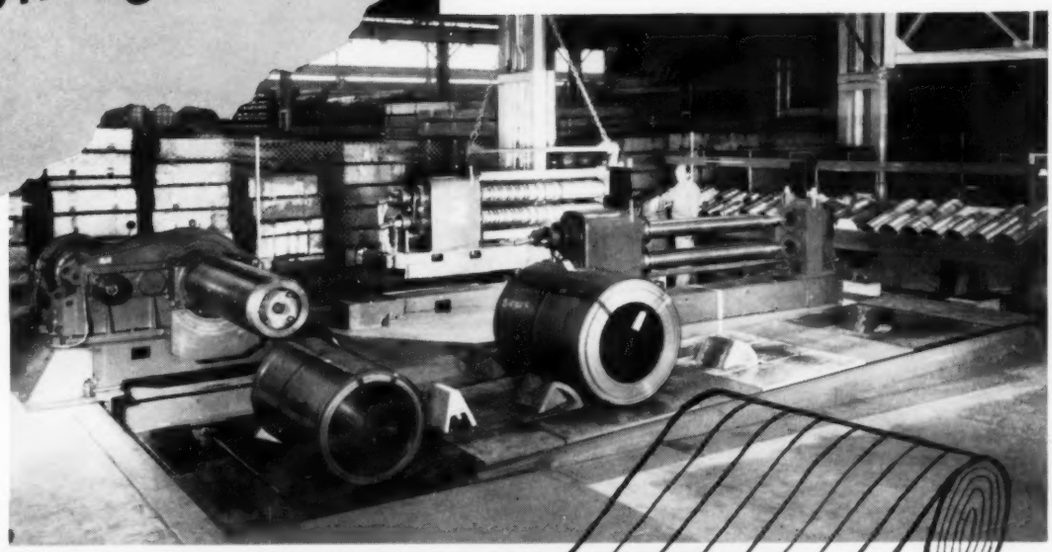
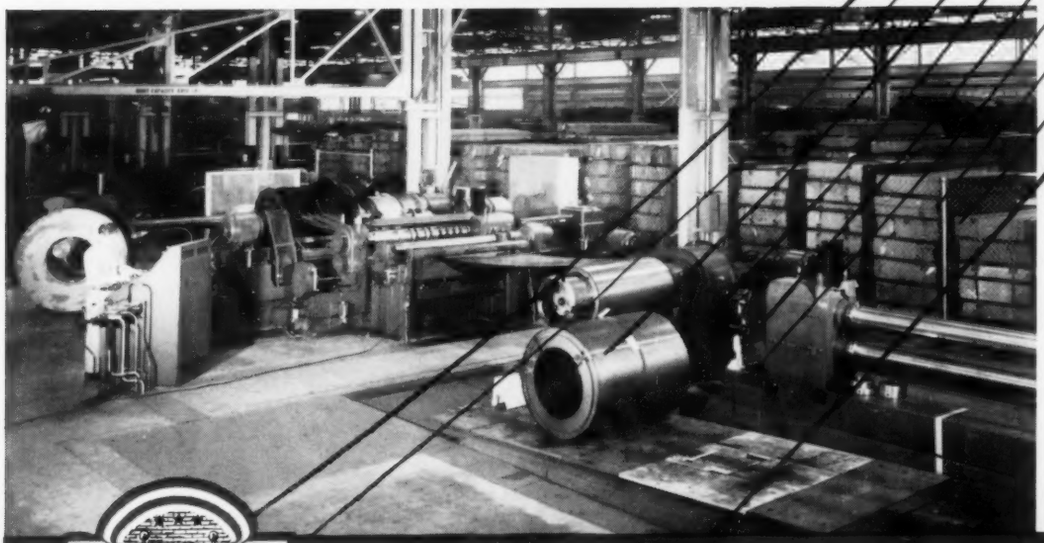


View shows coil and traverse, coil pay off reel, coil loading ramp and detachable slitter head.



Overall view of coiling line from entrance end.

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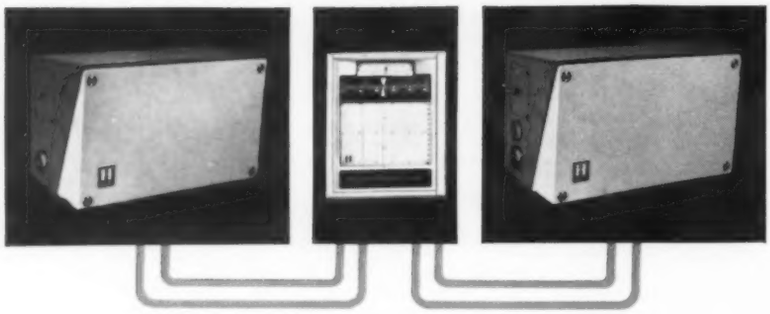

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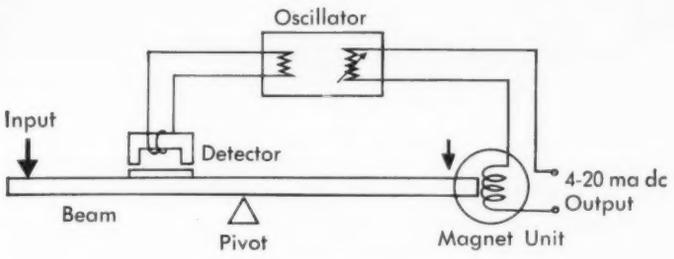
Delicate inputs thrive on the tender care of *ElectriK Tel-O-Set's force-balance feedback system*. This system, used as the basic circuit in *Tel-O-Set* transmitters, receivers, controllers, and other instruments, has proved itself in thousands of installations in the last five years. The force-balance feedback circuit increases the accuracy and dynamic response of the system by decreasing hysteresis effects and sensitivity to changes in ambient conditions.

Observe: (1) input force (from bellows, Bourdon tube, or displacement linkage) deflects pivoted beam; (2) air-gap in ferrite detector increases, (3) producing a change in inductance in oscillator circuit; (4) a portion of output current is fed back into magnet unit, producing a force on beam which is equal and opposite to input force; feedback balances beam. Full scale motion is only one-thousandth of an inch.

The advanced control engineering seen in force-balance feedback is carried through the entire *ElectriK Tel-O-Set* System. Specifically, there's no external power required at any field-mounted *Tel-O-Set* instrument. Line power connection is made only at the receiver. Two-wire d-c transmission eliminates shielding problems. The 4-20 milliamp signal range of the system gives a live zero and permits the use of the most reliable transistors available. The d-c signals



can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

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First in Control

SINCE 1885

75th YEAR

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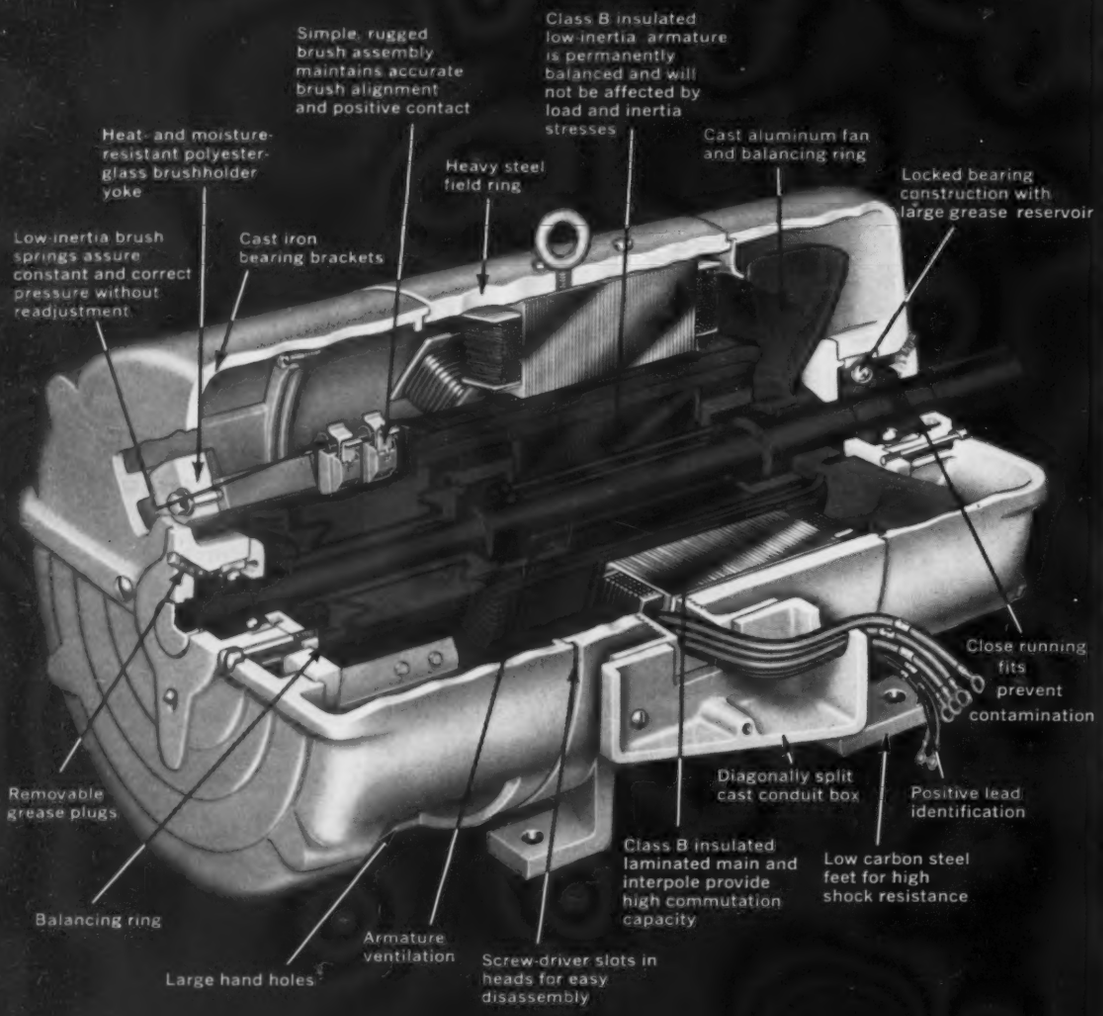
Here's the latest in D-C motor design: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Class B insulated low-inertia armature is permanently balanced and will not be affected by load and inertia stresses
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Large hand holes
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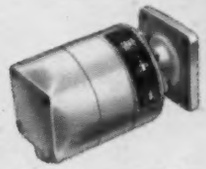
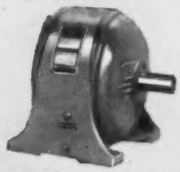


A-c tachometer for speed indication

A-c motor-driven blower with permanent dry-type filter for easy mounting on bearing bracket

Magnetic disc-type brake with d-c series or shunt, or a-c coils



Helical single, double, and triple reduction gear units for all ratios

New Louis Allis FLEXITORQ® D-C MOTORS

...offer you vastly improved commutation–low brush wear–400% short-time overload capacity–and unmatched flexibility!

Bear this in mind: The Flexitorq is *not* just another *rerated* d-c motor. It's *all new*—and it's been designed to give you more for your power dollar — in superior performance, matchless field flexibility, and unrivalled economy of operation and upkeep.

Advanced armature design and brush construction offers improved commutation, faster response, and lower brush wear. Class B insulation system provides exceptional thermal endurance... is rated for 60°C rise for continuous duty... and creates a barrier to moisture, acids, alkalis, and other contamination.

The net result to you is reliable, trouble-free power for constant and adjustable speed drives. For example, Flexitorq gives you 400% faster acceleration, plus much better deceleration, reversing, and speed changing. You can safely impose 400% intermittent and 15% continuous overloads — and the high-torque design is a welcome plus when you need extra power for hard-to-start machines.

The new Louis Allis Flexitorq is lighter and more compact than previous d-c motors... lets you squeeze more power into less space... yet is actually *easier* to service! Brushes and entire brush-holder assemblies can be quickly inspected and removed without major disassembly. And since brush springs remain conveniently attached to the brush holders, brush changing is a simple affair.

Flexitorq d-c motors are available in sizes from 1 to 400 hp — in various enclosures. See your nearby Louis Allis District Office for information and application help. Or write for Bulletins 3150 and 3200 to The Louis Allis Co., 450 E. Stewart St., Milwaukee 1, Wis.

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by FRED H. PADDON, Manager, Engineering and Sales,
Amerigear/Bliss Spindles, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio

Application and Selection of GEAR TYPE SPINDLES

Uniform velocities of the gear type spindles can aid in improving product quality while effecting maintenance economies. Best design requires evaluation of many factors.

GEAR type spindle applications since 1950 have steadily increased in number and size on hot mills, cold mills, tube mills and related equipment, with resulting benefit of reduced maintenance costs, and improved product finish and tolerance. See Tables I and III. This increase is compounded and necessitated by market demand for higher equipment operating speeds, torques and improved product quality.

Past history as a rolling mill and now also a gear

TABLE I
Gear Type Spindles, Application History (From Early 1950 through 1958)

Application	No. applications	Roll size, range, in.	Number of spindles applied			
			Modified straight tooth	Excessive crown tooth	Crowned flank tooth	Total
Cold mills						
4-High single-stand	69	4½–26	8	30	100	138
2-High single-stand	21	8–34	14	6	22	42
2 Stand tandem	4	19–21	4	0	12	16
3 Stand tandem	5	8½–21	8	6	18	32
4 Stand tandem	4	6¾–21	8	4	20	32
5 Stand tandem	4	3–23	10	0	42	52
Total—cold mills	107	3–38	52	46	214	312
Hot mills						
Rod and merchant	5	10–12½	0	0	61	61
2-High reversing	1	38	0	0	2	2
4-High reversing	4	8–32	0	0	7	7
2-Stand finishing	1	21	0	0	4	4
Vertical edger	1	36	0	0	2	2
Downcoiler	18	20–53	8	10	17	35
Wheel mill	1	16	0	0	2	2
Total—hot mills	31	8–53	8	10	95	113
Bridles, feed and pinch rolls	15	4–16	0	0	35	35
Continuous anneal lines	3	4–10	0	0	159	159
Leveler uncoil-recoil	52	2⅜–10	0	0	520	520
Tube, pierce and size	5	6–14	0	0	22	22
Straighteners, rim and ring mills	4	3–16	0	0	7	7
Calenders	2	—	0	0	5	5
Total miscellaneous	81		0	0	748	748
Total history (End of 1958)	219	2⅜–53	60	56	1057	1173
Total year 1959	47	1⅝–53	0	0	438	438
Grand total through 1959	266	1⅝–53	60	56	1495	1611

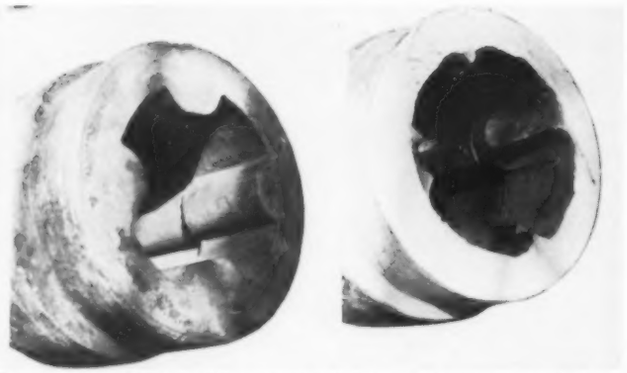


Figure 1 — Cast pods, operated at a 9-degree maximum angle, lasted two months.

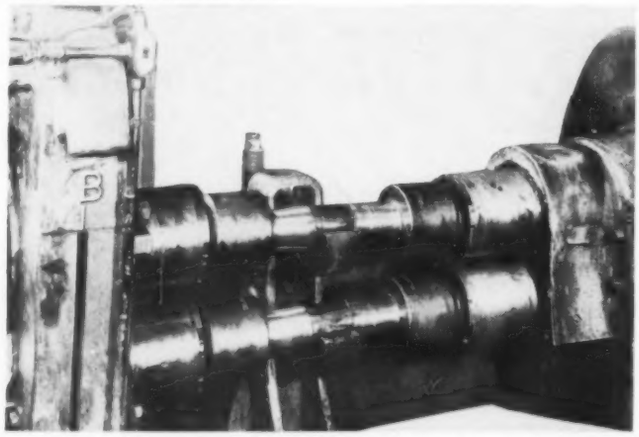


Figure 2 — Gear type design on a 2-high cold mill increased spindle life.

Figure 3 — Heads used for slipper type spindle.

Figure 4 — Slippers are made of bronze.

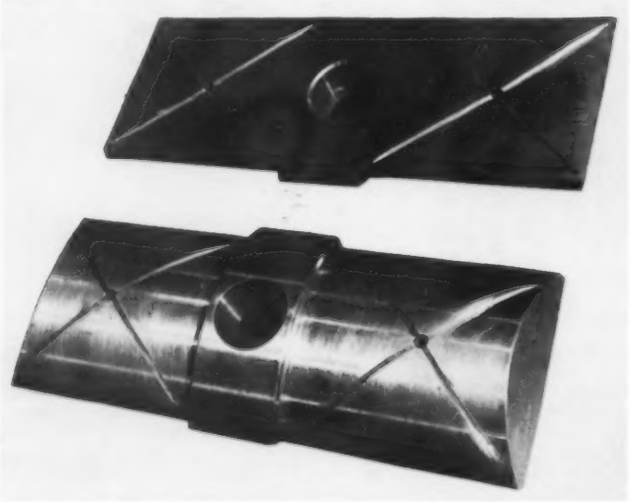


Figure 5 — Spindle conversion on a coiler reduced down-time.

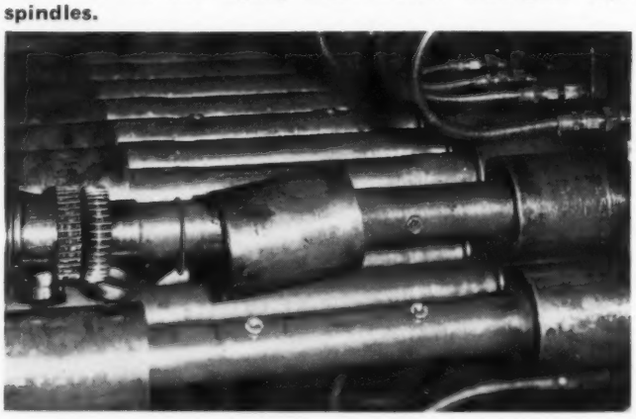
type spindle manufacturer has covered a transition through many spindle designs and tooth forms. This experience enables recognition of the pitfalls that can be avoided with proper selection thus arriving at a sound basis for satisfying the smallest or largest requirement.

Applications typical of this history are illustrated by Figures 1, 2, 3, and 4. Figure 5 illustrates existing equipment conversions, and Figures 6, 7, and 8 show gear type spindles incorporated in new equipment. Details of spindles are tabulated in Table II giving a description of application, outside diameter of spindle required, angularity and continuous normal capacity including application factor for shock and drive characteristics.

The cast pods shown in Figure 1, when operated on the mill, lasted approximately two months at 9 degrees maximum angle. Gear type crowned flank tooth spindles with an inherent $6\frac{1}{2}$ degree angularity have replaced them, are still in satisfactory operation after one year and show an excellent wear pattern for promised long life.

Slipper type spindles of 4140 heat-treated material

Figure 6 — A new flying shear leveler uses gear type spindles.



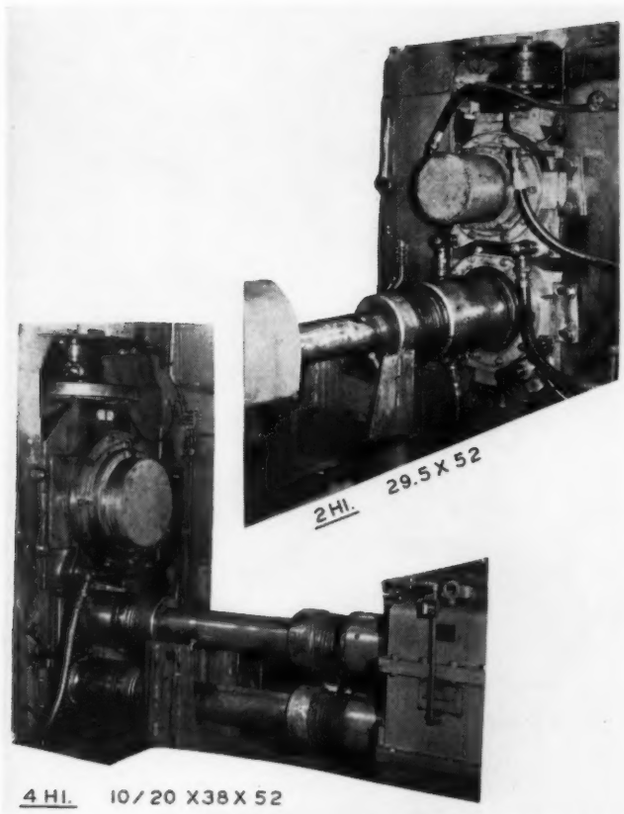


Figure 7 — Top view is a bottom roll driven, 2-high 29½ x 52-in. mill. Bottom shows a 4-high, 10 and 20-in. x 52-in. work rolls with 38 x 52-in. backup rolls.

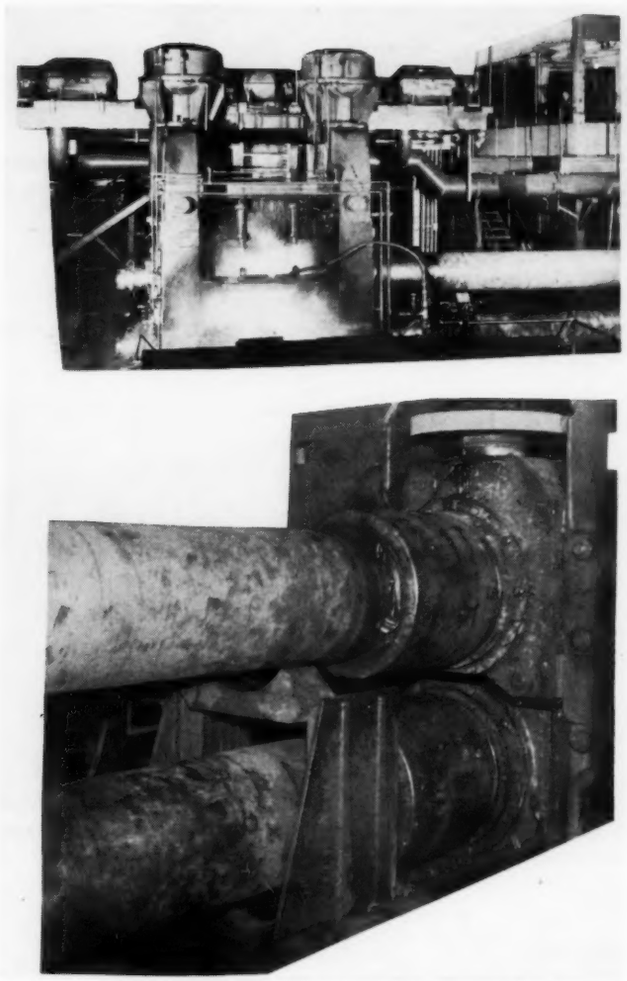


Figure 8 — These gear spindles have been in service for over three years on a 2-high, 38 x 52-in. hot reversing slabbing mill.

for maximum torque (Figures 3 and 4) have had frequent failures in one and one-half years of operation. A gear type spindle is now being manufactured as start of a replacement program, with several times original slipper type spindle capacity in same space limitation.

One hundred and fifty of these $2\frac{1}{8}$-in. outside di-

TABLE II
Details of Typical Gear Type Spindles

Application		Spindle				
				Spindle angle, deg		
Type	Roll size, in.	Outside diam, in.	Length, in.	Full load	No load	Normal capacity, in.-lb
2-High reversing hot mill	26 × 56	23	$93\frac{3}{8}$	6	$6\frac{1}{2}$	660,000
4-High reversing hot mill	30/36 and 55 × 96	31	$299\frac{3}{4}$	$4\frac{1}{4}$	$4\frac{1}{4}$	4,500,000
2-High reversing hot mill	32 × 52	24	118	3	6	2,025,000
17-roll flying shear leveler	$2\frac{1}{2}$ × 48	$2\frac{1}{8}$	22	2	4	1,400
2-High cold mill	10 × 10	$9\frac{7}{8}$	60	2	4	51,400
4-High back-up roll driven cold mill	$4\frac{1}{2}$ and 16 × 16	$10\frac{1}{8}$	$75\frac{5}{8}$	2	4	114,000
4-High back-up roll driven cold mill	$6\frac{1}{2}$ and 16 × 14	11	155	3	3	124,000
4-High back-up roll driven cold mill	19 and 49 × 48	16	$149\frac{9}{16}$	2	2	63,000
4-High reversing cold mill	18 and 49 × 56	16	$108\frac{5}{16}$	$3\frac{1}{2}$	$3\frac{1}{2}$	630,000
2-stand 2-high temper mill	$29\frac{1}{2}$ × 52	18	$89\frac{7}{8}$	3	6	360,000
2-stand, 4-high temper mill	10/20 and 38 × 52	18	$89\frac{7}{8}$	3	6	360,000
3-stand tandem cold mill	21 and 53 × 56	19	$117\frac{1}{4}$	2	5	1,630,000
4-stand tandem cold mill	$19\frac{1}{2}$ and 51 × 52	16	$99\frac{1}{2}$	1	4	946,000
4-stand tandem cold mill	21 and 56 × 71	18	111	$2\frac{3}{4}$	3	1,225,000
5-stand tandem cold mill	23 and 56 × 52	22	$116\frac{3}{4}$	1	4	900,000
Merchant mill	8 × 12	$8\frac{1}{2}$	$51\frac{5}{8}$	2	2	29,200
2-High hot reversing strip mill	32 × 56	$26\frac{1}{2}$	292	5	5	1,890,000
2-High hot reversing slab mill	38 × 52	32	$335\frac{13}{16}$	1	2	3,970,000
Downcoiler pinch roll	28 × 66	$9\frac{1}{2}$	107	3	3	15,200
Downcoiler pinch roll	...	$13\frac{5}{8}$	90	3	3	15,750
Tube straightener	$4\frac{1}{2}$ to 16 tube	14	$86\frac{3}{4}$ to $183\frac{3}{4}$	Roll end 10 Drive end 4	11 5	140,000
Hot wheel mill	Railroad wheels	$13\frac{3}{4}$	$142\frac{3}{4}$	8	13	181,000

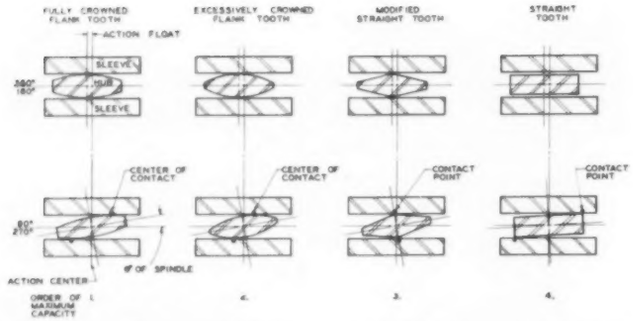


Figure 9 — The various types of tooth form illustrated show contact action.

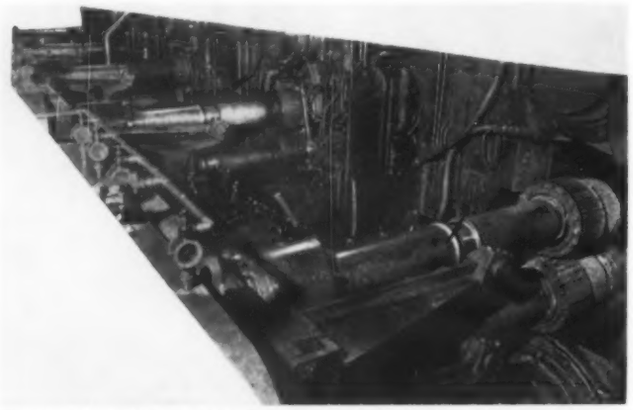


Figure 10 — Crowned flank tooth spindles have replaced original equipment on this 5-stand tandem mill.

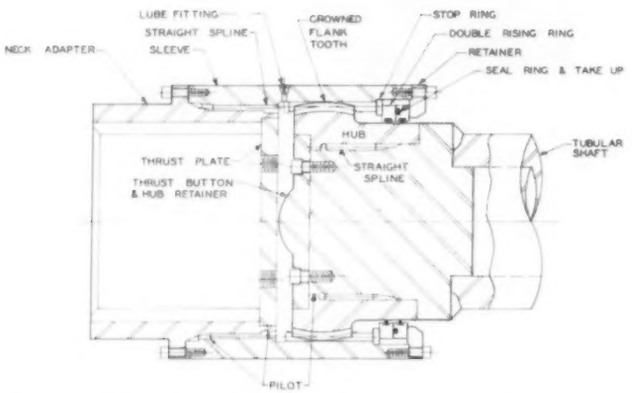


Figure 11 — Replaceable sleeves and hubs reduce maintenance cost.

Figure 12 — Older designs called for fine pitch and peaked tooth flanks.

Figure 13 — Controlled, crowned tooth flanks and large pitch have greatly increased spindle capacity.

ameter leveler type spindles (Figure 6) are now in operation. Originals have operated approximately six years. A set of 1½-in. outside diameter spindles are now being applied.

Early temper mill spindles are an example of modified straight teeth (see Figure 9) operating a relatively low angle and low torque, within their design limitation. Motor height is adjustable so that spindle angularity is kept within capacity limits of this type tooth.

Modified straight tooth spindles were applied to this 7000-fpm 5-stand tandem mill (see Figure 10), with long spindles and low angle requirements. Original spindles have failed in the high torque No. 2 Stand and crowned flank spindles are now in satisfactory operation. Complete spare crown flank spindles are on hand for the remaining stands.

A set of 2-high, 38 in. x 52-in. reversing slab mill spindles have operated satisfactorily for two and one-half years, and are now being modernized to incorporate replaceable gear sleeves and hubs similar to Figure 11. Wearing parts are of minimum cost, and can be changed with little mill delay in case of a wreck or after long wear life.

Hot wheel mill spindles have been in operation 2½ years at 13 degrees no load angle, contacting blank at 8 degrees full load and varying under full load for each blank down through zero angle. Wear pattern to date is excellent, promising long life.

DESIGN

Tooth size and shape have progressed from relatively fine pitch, Figure 12, with concentrated high crowned or peaked tooth flanks to large pitch, Figure 13, with

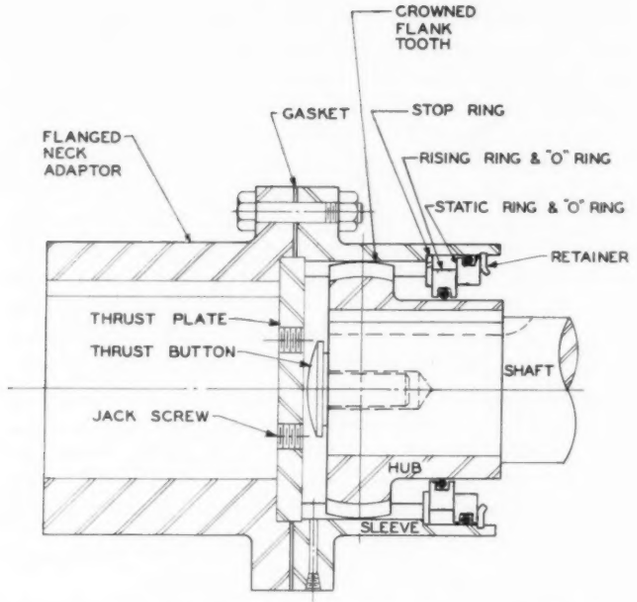


Figure 14 — This high angle, flange type coupling is made of heat-treated materials.

Figure 15 — Special telescoping spindles improved pinion and roll change methods.

controlled crowned tooth flanks and special tooth tip pilot to provide maximum capacity for specific angular and offset requirements, concentricity and brute strength for handling abuse. Over-all design has progressed to provide for convenient time saving disengaging (see Figure 14), improved pinion and roll changing methods and special telescoping spindles, Figure 15, to incorporate minimum mass wearing parts of adequately heat-treated material for extended life. For abrasive operating conditions and large spindles, readily replaceable low cost splined, welded or bolted interchangeable wearing parts have been provided.

ROLL CHANGE

Figure 16 illustrates a center-mounted spindle support utilized with split type spindles where roll end spindle hub and sleeve are split for roll change. This practice is best suited for, and should be limited to, conversion of old mills where special roll necks with splines or pods prohibit re-entry of roll necks into nonsplit spindles. Disadvantages are contamination of lubricant, loss of lubrication, tooth damage in re-entry and handling and necessitation of extra roll end sleeves on stand-by rolls.

Also shown on Figure 16 is a housing mounted spindle support utilizing nonsplit spindles recommended for new mills and for conversion of existing mills where roll necks provide for pulling roll neck out of roll end sleeve. Roll end sleeve support forks are carried by a cross member that passes between shafts, not limiting minimum roll size, and are adjusted by hydraulic cylinders maintaining the roll end sleeve perpendicular to housing face at all times during roll change, in a readily adjustable position to meet varying roll size. Cost is equivalent to a center-mounted spindle carrier and design has no rotating parts for low maintenance cost. Compared to center-mounted split type spindle support, cost is also further offset by not requiring extra sleeves on stand-by rolls. Gear type spindles with proper tooth pilot do not require spindle carriers for mill operation, but only a support during roll change.

As spindle teeth of nonsplit spindles, Figure 17, remain in contact and are not remeshed for each roll change, crowned tooth flanks lap-in with matching teeth for maximum capacity, lubricant remains totally enclosed and is not contaminated, and unreliable centering springs are not required.

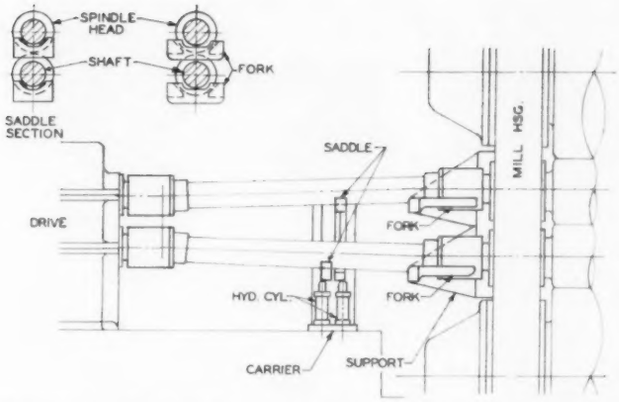


Figure 16 — Two spindle supports are shown, the center mounted and the housing mounted.

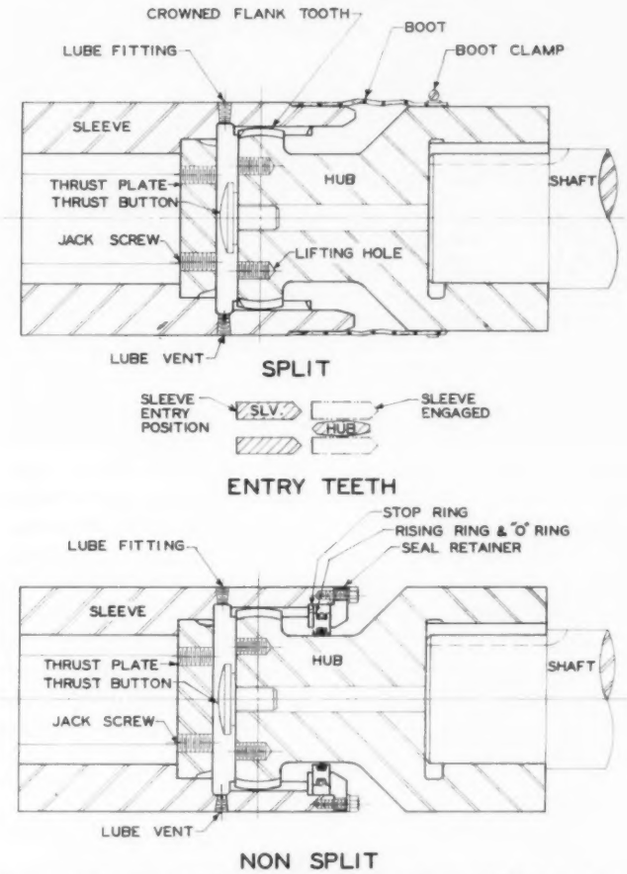


Figure 17 — The split and nonsplit spindle designs show seals and general construction.

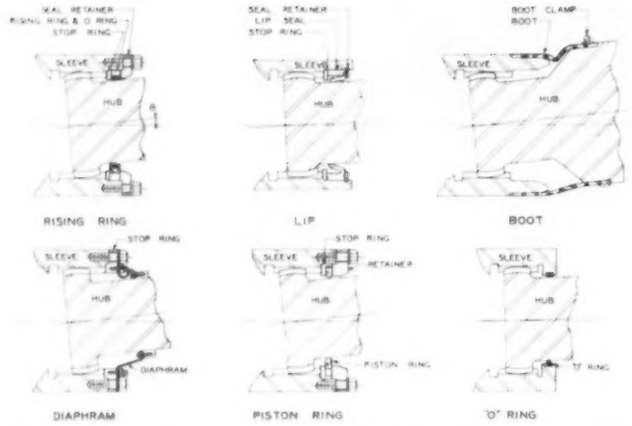


Figure 18 — Tooth life depends on containing the lubricant with adequate seals.

SEALS

As tooth life, regardless of material or hardness, is dependent upon containment of adequate uncontaminated extreme pressure lubricant, various seals have been utilized (Figure 18). For nonsplit cold and hot mill applications any of these seals can be utilized, with provision of stop rings to prohibit spindle parting. Split type spindles require boot type or inverted rising ring seals. Nonrising compressible or O-ring seals are limited to low angle operation to avoid seal extrusion, fatigue and wear. Rising O-ring or piston ring seals allow for higher angular operation, as complete metal shrouds accommodate required seal rise on adjacent parallel surfaces. Rising O-rings provide for a compressible seal medium to accommodate minimized elliptical hub tilt action, while piston rings under similar condition must maintain a curved seat and clearance to accommodate this action. Abrasive conditions are best met with nonmetallic contact seal surfaces, that have compressibility to maintain contact and cope with abrasive materials. Boots and diaphragms are successful where not subject to flexing or tensions of high angularity, mechanical abuse or excessive heat conditions.

PROCESS

Standard straight internal teeth of sleeves are cut on a conventional gear shaper. Crowned flank or modified straight flank hub teeth are cut on a gear hobber with various modifications to provide flank shape. The shape of hub teeth generated is most important, as it determines ultimate spindle capacity, for given wear life and ability to carry tooth flank loads on available extreme pressure lubricants.

TOOTH DISCUSSION

For purpose of discussion, tooth action is illustrated by Figure 19 with one spindle end shown under maximum spindle angle theta, making hub teeth in 90 and 270-degree horizontal plane subject to maximum angle theta of spindle, while hub teeth at 0 and 180-degree vertical plane remain with center line of tooth in line with spindle, or with zero angle to mating internal teeth. Since teeth at 90 and 270-degree horizontal plane utilize backlash, male teeth at 0 and 180-degree vertical plane approximately center in female tooth space and backlash is divided with no contact or load carried. Therefore as shown in end view, and in pitch line development Figure 20, for a given maximum angular requirement, two teeth carrying maximum load are located at 90 and 270-degree horizontal plane position B, and adjacent teeth around pitch line above and below horizontal plane, due to deflection and inherent tooth flank contour, progressively from B to A have less contact and carry less load. Number of teeth in contact and individual tooth flank load carrying capacity vary with hub tooth flank shape, which by mechanical analysis should be of compound curved shape to meet specific angle theta required.

A spindle cut for maximum angle theta when operated at an angle less than theta will have a greater number of teeth in contact resulting in greater torque

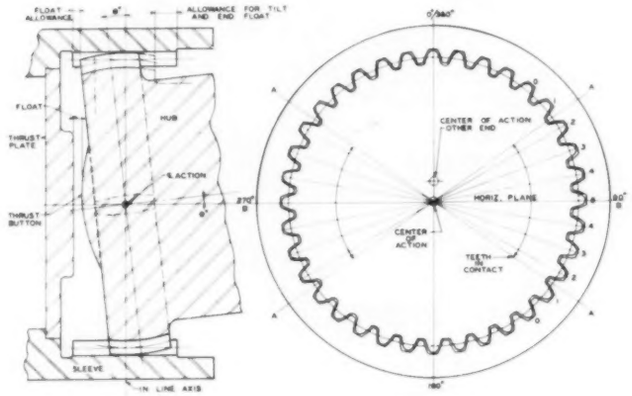
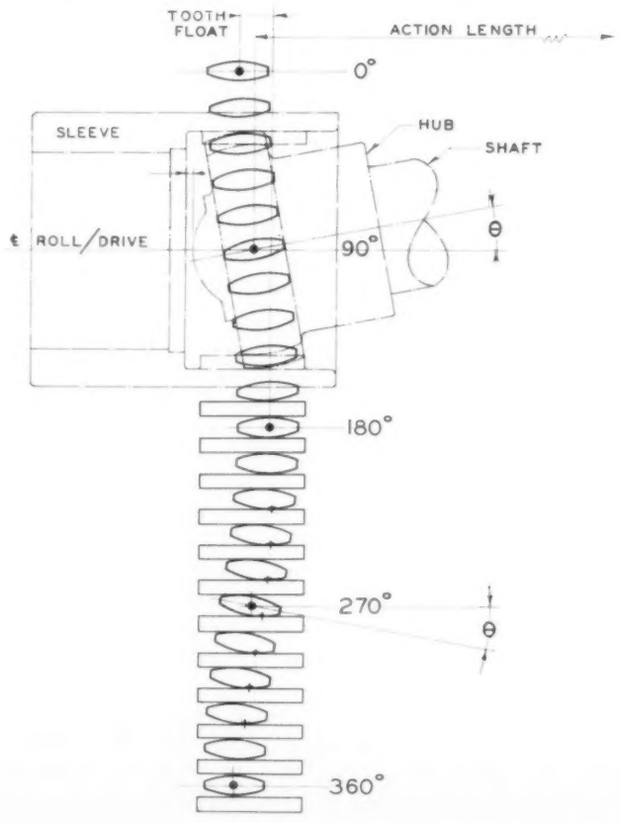


Figure 19 — Tooth loading is unequal. The number of teeth in contact varies with the angle.

Figure 20 — Two teeth carry maximum load.



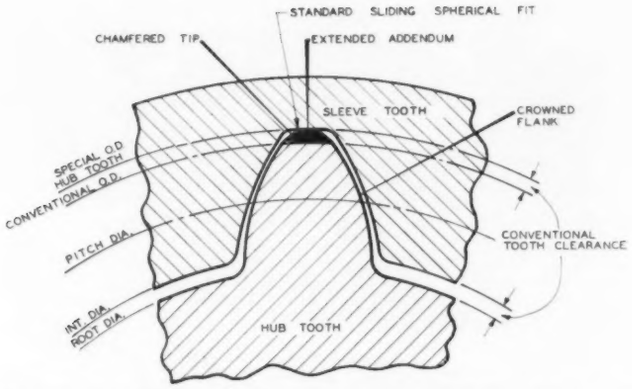


Figure 21 — The extended addendum of the tooth reduces rattle and aids in distributing the load.

capacity. At zero angle theta, excluding machining inaccuracies, all teeth are in contact for maximum capacity.

ANGULAR VELOCITY

The velocity is theoretically constant for any angle theta excluding machining inaccuracies, and minute variation of tooth contact entering or leaving each of four load areas of maximum flank load at B and minimum flank load at A, Figure 19. Since hub and sleeve are of equal number of teeth, and are continuously engaged, there is no conventional gear involute action. Entry into flank load contact position A and exit is smooth with minimum shock. In each case, this transition from no load at "A" to full load at "B" and vice versa, is gradual in a pair of opposed simultaneous equalizing arcs. By analysis of each tooth load, polar angle and radius of action, two average loads at equal radii result at B (90 and 270 degrees in horizontal plane) producing constant velocity regardless of angle theta. Properly crowned teeth, when operated in matched pairs, lap out irregularities and the spindle even more closely approaches constant velocity and develops maximum capacity.

TOOTH COMPARISON

Analyzing the various tooth flank shapes shown in Figure 9 under the above requirements, conventional straight flank teeth have angularity limited by allowed backlash, and any angularity results in capacity being limited by high concentration of stresses on ends of a very low number of teeth.

With modified straight flank teeth end stresses are eliminated, but, since the tooth flank angle cannot match varying tooth angular requirement (see Figure 20), tooth load is concentrated on the peaked flank centers of a limited number of teeth. The number of teeth in contact is limited by lack of flank curve necessary to contact maximum number of adjacent teeth. Since a spindle at maximum angle theta must still have running clearance, and is usually operated at a lesser full load angle, the tapered flank cannot be utilized at any time.

With excessively crowned flank teeth a little improvement is gained as tooth end loading is eliminated, but capacity is sacrificed by high concentrated stresses of excessively curved flanks and flank curve is not ideal for maximum number of teeth in contact.

By provision of selected crowned flank teeth with flanks curved to suit specific angular requirements, the flattest flank curve provides maximum capacity per tooth, and a maximum number of teeth maintain con-

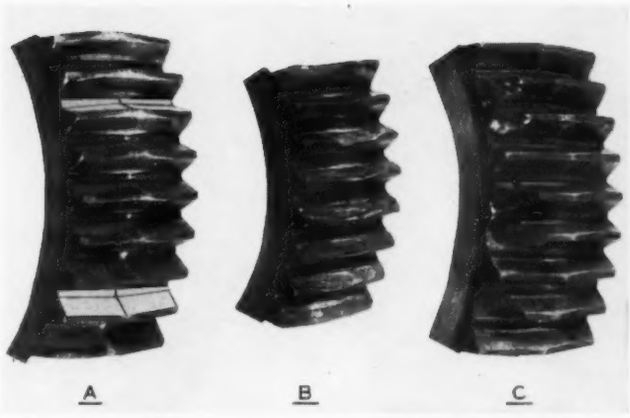


Figure 22 — High stresses and a varying load angle have ruined the teeth.

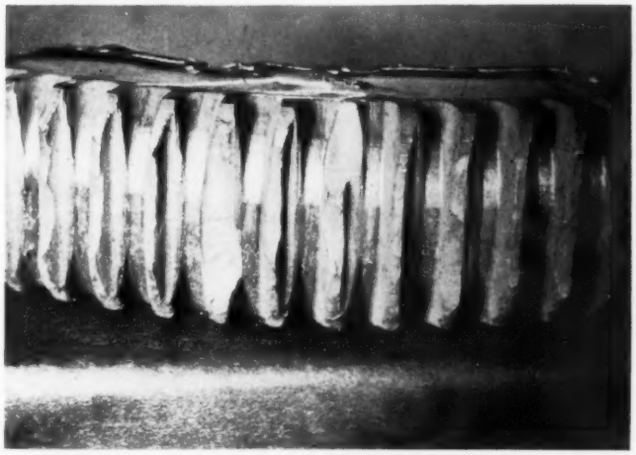


Figure 23 — Highly concentrated flank stress and excess wear caused beam failure of the teeth.

Figure 24 — Special entry teeth are used to allow ease of re-entry on split type spindles.

Figure 25 — Wear pattern confirms proper design.

tact combining for greatest spindle torque capacity. As spindle life varies approximately as the cube of spindle torque capacity vs torque load, this increased built-in spindle capacity results in greatly extended life. By doubling built-in spindle torque capacity for a given torque load, life is multiplied eight times.

TYPICAL TOOTH SECTION

Figure 21 compares conventional tooth proportion of normal root and tip clearance to a tooth with special extended addendum. Teeth of conventional design, under no load, float and rattle to absorb root and tip clearance. By providing a special extended hub tooth addendum, chamfered tip and spherical outside diameter, teeth act as pilots under no load, carrying spindle weight and avoiding rattle. Tooth flank loads are directed away from tooth fillet to flank proper for ideal load distribution and beam strength. With crowned flank teeth and special extended addendum, under no load, hub tooth tips pilot spindle concentric, and under load the four load areas, Figure 19, have component forces passing through center of spindle action assuring concentricity. This ideal concentricity is an additional benefit as it eliminates the need for continuously rotating spindle carrier.

MODIFIED STRAIGHT TOOTH

This actual wear pattern (Figure 22) shows effect of high concentrated stresses on tooth flank peaks and the result, at sector C, of attempting to accommodate a

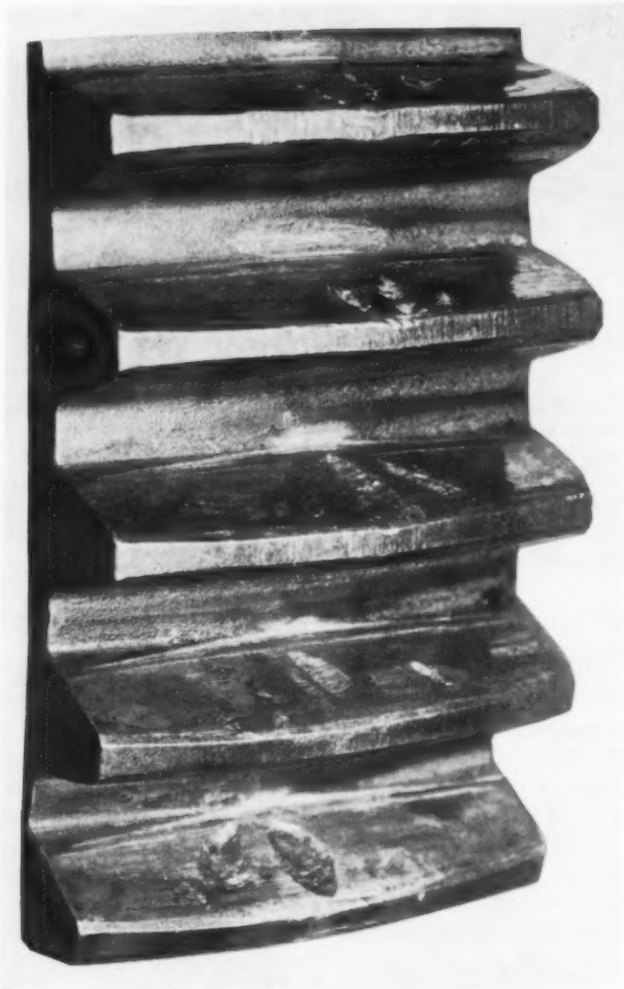


Figure 26 — Improper lubrication caused this gear failure.

continuously varying angle on noncurved straight tapered flanks.

EXCESSIVELY CROWNED FLANK TOOTH

Figure 23 shows wear patterns as a result of high concentrated flank stresses resulting from excessive crown, and shear and beam failure after excessive wearing-away of teeth.

Typical crowned flank teeth are designed with tooth lengths and crowns selected for specific conditions. For example the relatively wide teeth are more suitable for low angularity and high torque whereas the narrower proportions are more suitable for high angularity.

ENTRY TEETH

Figure 24 shows special entry teeth similar to a synchro mesh automotive transmission tooth to facilitate re-entry of split type spindles.

CROWNED FLANK TOOTH WEAR PATTERN

Good wear patterns as a result of properly selected teeth and use of an extreme pressure lubricant should be a typical occurrence. See Figure 25.

Lubrication—Figure 26 shows a crowned flank tooth

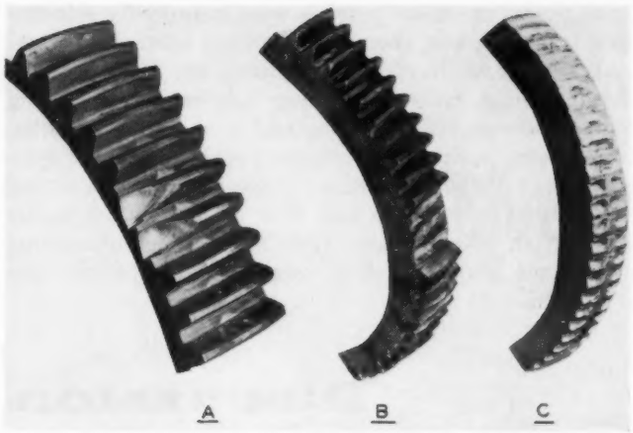


Figure 27 — Damage results from exceeding spindle angularity.

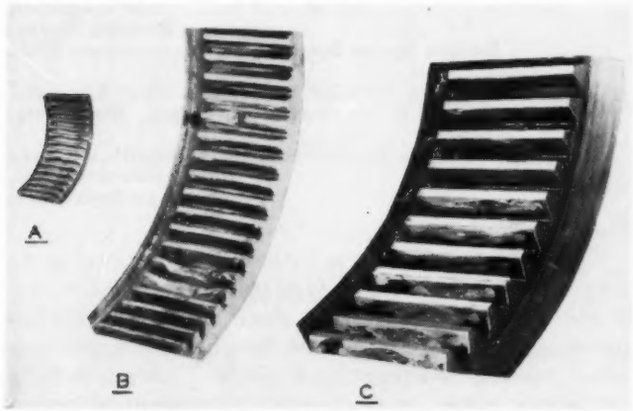


Figure 28 — Lubricant contamination can have serious results.

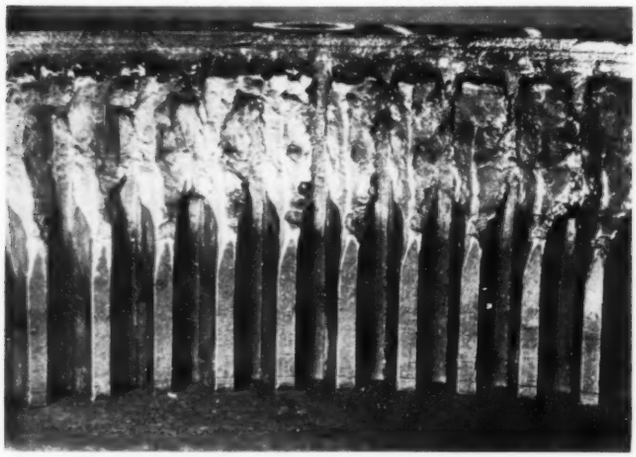


Figure 29 — Failure was due to hub riding on end of internal sleeve teeth.

illustrating damage as result of using a nonextreme pressure lubricant. This tooth upon examination after its first few weeks of operation with nonextreme pressure lubricant, showed evidence of welding, scouring and spalling due to excessive heat. A complete washdown, and utilization of extreme pressure lubrication, resulted in healing of original damage and the illustration shows condition after approximately two years' operation.

Improper tooth design—The effect of application of a tooth design with improper no-load maximum angularity is rapid breakage and wear. Initial damage, see Figure 27, can result in failure of several teeth in the 90 and 270-degree horizontal plane, which progresses

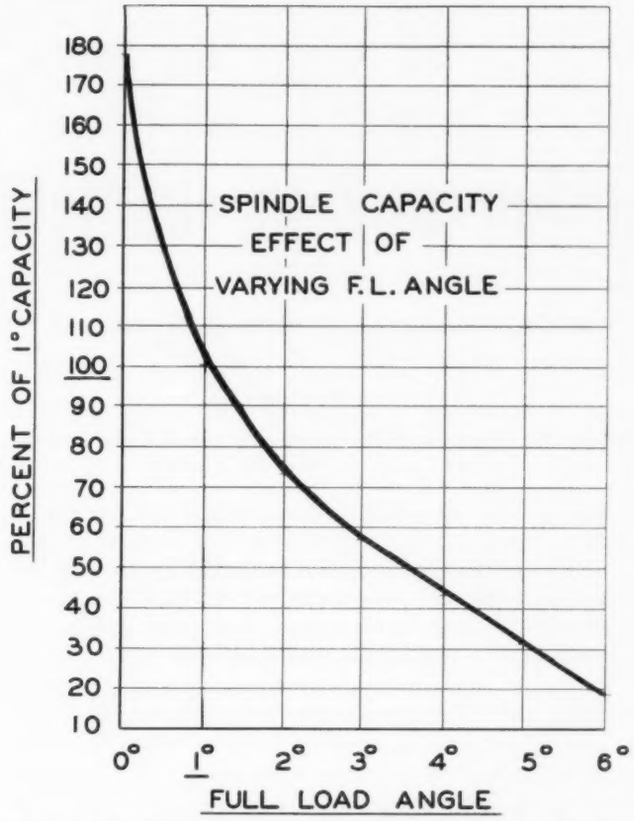


Figure 30 — The curve indicates the relation of full load angle to the percentage of full load capacity.

by repeated shock to teeth adjacent to missing teeth passing through maximum load area of horizontal plane and causing early failure of remaining teeth.

Sleeve tooth damage—Sector A, Figure 28, shows effect on internal sleeve teeth of abrasive contamination of lubricant. A similar pattern results with use of nonextreme pressure lubricant. Sector B shows effect, on internal sleeve teeth, of hub teeth improperly designed for no-load maximum angularity. Sector C shows an early scouring and welding stage of improper nonextreme pressure lubrication.

Figure 29 shows how insufficient internal tooth length and inadequate thrust buttons will allow hub to ride to end of internal sleeve teeth causing concentrated beam load and failure.

SUMMARY

Figure 30 shows that with a spindle selected for given conditions and materials, assuming 6-degree no-load angle theta and 1-degree full load angle theta, that 100 per cent capacity is obtained. If this same 6-degree spindle is operated at 2-degree full load angle, capacity is approximately 73 per cent of 1-degree capacity, and if operated at zero-degree full load angle, capacity is 178 per cent of 1-degree capacity. This condition is no different than a similar characteristic that has long been ignored on slipper and pod type spindles.

By making new mill spindles of adequate length to obtain low angularity, additional capacity and wear life can be gained. Pinion stands should be raised to a neutral elevation so that spindle angle theta is minimized and distributed equally to top and bottom spindles. Back-up roll fillers on 4-high mills should be

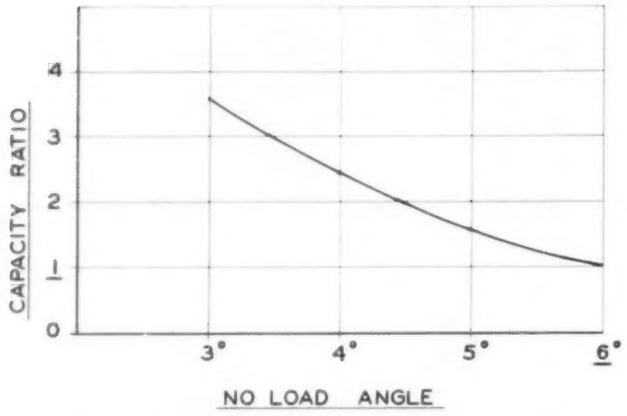


Figure 31 — Capacity is gained as spindles are lengthened.

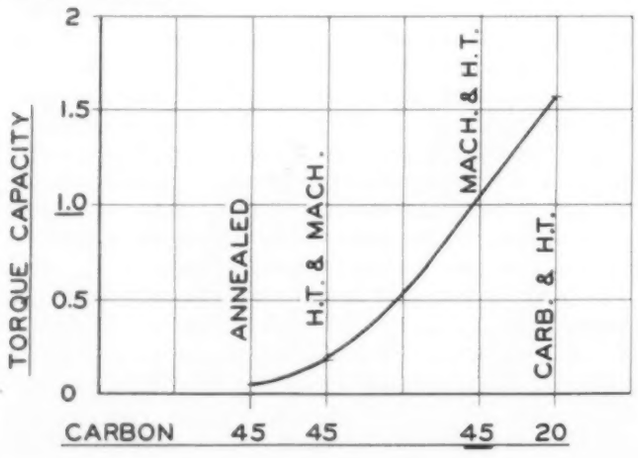
diligently used to maintain pass height and limit mill opening. Selection of mill screws should be closely analyzed for similar limits. Spindles should be selected for maximum operating condition of roll size, load and product. Operation at less than maximum design full load angle increases capacity and extends life.

By giving thought to maximum no load angle when selecting new mill spindles, considerable capacity can be gained by making spindles of great enough length to keep angle theta low, and by keeping mill maximum opening to minimum. See Figure 31. Roll changing methods should be checked to prohibit back-breaking of spindles by crane or other mechanical means. For example this graph shows that with a spindle for given conditions and materials selected for 6-degree maximum no load angle, design capacity is one or 100 per cent. If same spindle can be designed for 5-degree no load angle, capacity is 160 per cent, etc.

Both full load angle and no load angle dictate tooth shape, and decidedly effect ultimate spindle capacity and spindle life. Figure 32 shows a wide latitude of materials can be utilized to provide adequate torque capacity and desired life for given requirements.

For example with 1045 tooth parts machined and then heat treated as one or 100 per cent for comparison, the same 45 per cent carbon material non-heat treated would only have 15 per cent of this capacity. Similar parts of 0.20 per cent carbon carburized and heat treated would have 160 per cent of this capacity.

Figure 32 — Material selected has important effect on torque capacity.



As observed on early trials with improperly selected gear type spindles, there is a crowned tooth shape and material for each specific requirement. Wrong tooth shape, wrong material, wrong lubrication or wrong over-all design specifications can have drastic results. Conversely, with proper selection and design gear type spindles can be a justified investment on existing equipment conversions and new equipment manufacture. With present gear type spindle manufacturing equipment and know-how, benefits, and justification are sound.

Discussion

PRESENTED BY

W. W. JUSTICE, Chief Engineer, Youngstown District Works, United States Steel Corp., Youngstown, Ohio

THOMAS M. KILGO, Senior Electrical Engineer, Armco Steel Corp., Butler, Pa.

W. E. MATTHEWS, Superintendent Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

W. W. Justice: There is little doubt concerning the soundness of applying gear type spindles to certain uses. It has not been many years since the equipment engineer was limited to spindle designs, which at best, only approximated constant velocity. This put definite limitations upon product quality, equipment safety factors, prime mover sizes, etc.

Today, the gear type spindle has proved itself adequately to permit its application to the many functions where constant velocity angular drives are required. The day is not far away when the requirement to stay competitive in both cost and product quality will dictate application of finely designed and accurately fabricated elements, such as these spindles, in heavy mill equipment.

Thomas M. Kilgo: We are using the gear type spindle on our horizontal wheel rolling mill edging rolls. They are subjected to eight degrees maximum angularity or misalinement and have been operating for over a year with no trouble. They have been doing an excellent job for what is a rough application.

W. E. Matthews: Some improvements have been on tooth design and materials. This is logical as this is the source of most failures. However, there is no need for the full involute tooth form for this application as the members are not rolled in the same manner as gears. A modification toward a straight sided tooth should give better contact area for load carrying capacity.

There are several applications of gear type couplings on spindles in Sparrows Point and there have been failures. Some failures have been due to the tooth being too small to carry the load when operated at near maximum designed angles, others are due to abuse during roll changes and others because of poor sealing. Recognizing that a certain amount of these hazards will always be on a steel mill application, the designer and manufacturer of the gear type coupling must build his coupling to meet these conditions with improved design, close machining tolerance and better materials. ▲

Blowing Methods in Steelmaking

The production of tonnage oxygen at low cost has stimulated interest in pneumatic processes, which have made large strides in vessel size, amounts of permissible scrap addition and grades of steel which can be produced.

by G. YOCOM,
Assistant to General Manager,
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Chief Metallurgical Engineer, Bessemer
Steubenville Works,
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THE pneumatic process as invented by Henry Bessemer, an Englishman, and William Kelly, an American, opened the way to tonnage production of the first relatively low cost steel the world had known up to the years 1856–1858. The process was adopted in Europe and the U. S. and the mass production of steel was on its way.

Raw materials, scrap availability, and fuel economy were to govern the extent of its use in various parts of the world.

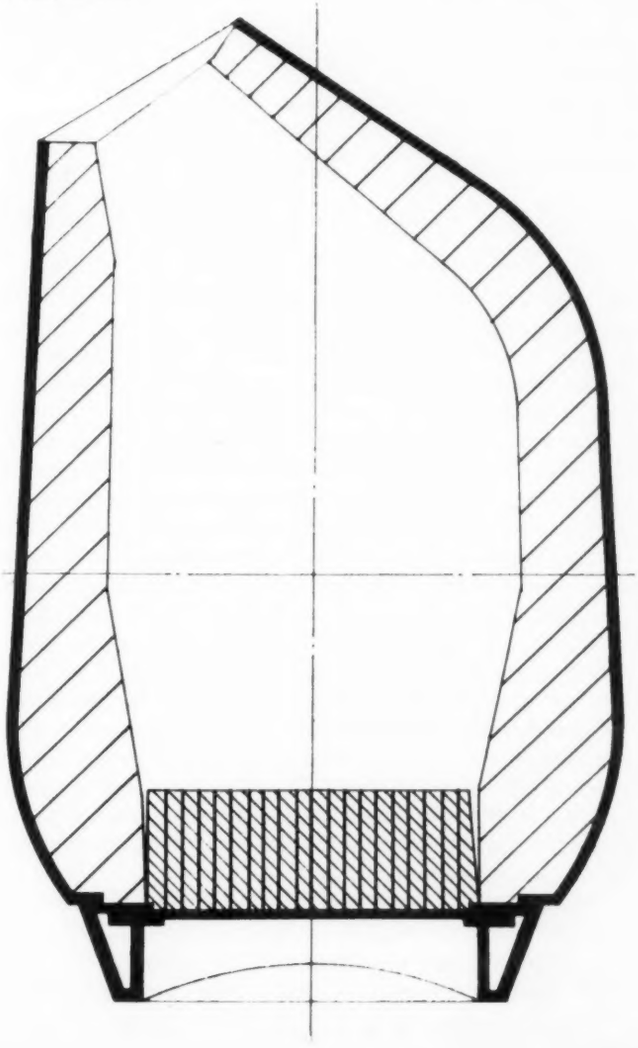
In the U. S. low phosphorus ores permitted only the use of the acid bessemer, producing a steel relatively high in phosphorus content which being blown with natural air was high in nitrogen and could consume only seven to ten per cent of scrap. Cheaper fuels, an abundance of scrap and certain restrictions in end use of acid bessemer steel directed American steelmakers to more or less abandon the pneumatic process and resort to the basic open hearth.

In Europe local phosphoric ores made the use of the Thomas basic-lined converters ideally suited to their raw materials situation. Scarcity of scrap and the high cost of fuel encouraged its continued use over the open hearth and the bulk of European commercial grades of steel is made by this process. Although dephosphorization was accomplished in the basic bessemer, the problem of high nitrogen content resulting from the use of natural air as the blowing medium remained to plague the steelmaker and the demand for lower nitrogen steel with lower strain aging and age hardening characteristics gradually increased.

The development of the Linde-Frankl process for the tonnage production of pure oxygen at low cost paved the way to a solution of the problems normally associated with air-blown pneumatic processes and has stirred a world wide re-birth of interest in this simplest method of producing steel.

Metallurgical benefits achieved by the use of oxygen

Figure 1 — The basic converter has been most widely used in Europe because the majority of European ores are phosphoric.



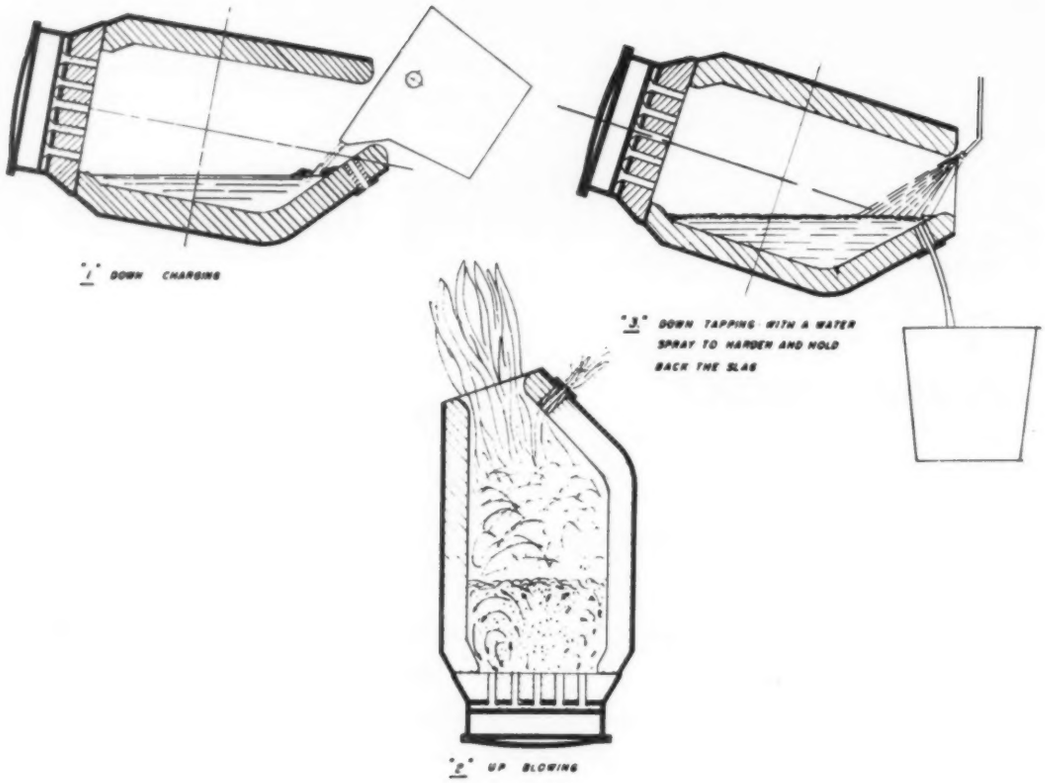


Figure 2 — The acid converter permits only the utilization of low phosphorus ores, for very little phosphorus can be removed in the process.

are well known. Steelmakers are now in the process of studying and developing the technological aspects of the new tool to determine the process or practice that will best suit their individual needs.

It is the purpose of this paper to describe the various pneumatic processes developed to date.

ACID BESSEMER

Bessemer steel as made in the U. S. is produced by the acid process, using iron ores of 0.045 per cent and under in phosphorus content. A portion of the converter capacity in the U. S. is utilized for producing blown metal from higher phosphorus basic iron for open hearth duplexing.

The process is conducted normally in bottom blown converters of 12 to 40 tons capacity. The orthodox or ordinary practice consists of blowing compressed natural air up through the bath of molten iron. The only source of heat is through the exothermic reactions of the oxidation of Fe, Si, Mn and C. Extraneous fuels are not required. Heat balance is governed by the chemistry of the hot metal and the cooling effect of the inert nitrogen permitting only comparatively small percentages of scrap in the charge. The acid slag does not dephosphorize or desulphurize and the use of natural air introduces high nitrogen contents in the finished steel (0.010 to 0.018 N_2). The additional stiffness imparted to certain products by the presence of these elements causes bessemer steel to be selected for limited applications.

At Wheeling, a method for dephosphorizing acid bessemer steel developed by Yocom[1] * about 20 years ago is still in continuous use. This method combined with the use of steam/oxygen as the blowing medium has produced steel, showing properties similar to open hearth steel of the same chemistry, in the sheet and pipe products to which it was applied.

The dephosphorizing is accomplished by treating the blown metal as it is poured into the ladle with a mixture of strongly basic and oxidizing materials along with the ferromanganese additions. The ingredients of the dephosphorizing material consist of burnt lime of pebble size, soda ash, roll scale and fluorspar added in the cold solid state. This mixture is properly proportioned to produce a basic oxidizing slag of low melting point. Phosphorus of 0.090 per cent in the blown metal is reduced to a range of 0.015 to 0.040 per cent in the finished steel.

To lower the nitrogen content, equipment was provided for blowing with steam and oxygen and two extensive runs were made. The blowing gas consisted of 60 per cent oxygen and 40 per cent steam by volume. Natural air was excluded entirely. This mixture was proportioned so as to be thermally equivalent to blowing with natural air.

The blowing time with this mixture was 70 per cent of that with natural air. Heats (15 tons) were blown in six to seven min, as against nine to ten min with natural air.

Once proper control was established, the oxygen consumption was 1500 to 1600 cu ft with 75 lb of steam per ton of steel. The nitrogen content of the steel ranged from 0.0008 to 0.0022 per cent, with an average well below 0.002 per cent.

The finished steam-oxygen blown, ladle dephosphorized, acid bessemer steel then contained 0.002 per cent nitrogen with phosphorus in the range of 0.015 to 0.040 per cent. This steel is applicable to low carbon rimmed or capped grades for the same sheet products normally considered in the field of open hearth steels.

* Numbers refer to Bibliography at end of paper.

TABLE I
Basic Bessemer Practice

	Normal blow natural air	Oxygen enriched air and one slag	Oxygen enriched air and two slags	Steam/oxygen and one slag	Steam/oxygen and two slags
Phosphorus, per cent maximum in steel →	0.050	0.050	0.025	0.050	0.025
Nitrogen, per cent maximum in steel →	0.015	0.010	0.010	0.0025	0.0020
Yield, per cent	87	88.5		87.5	
Oxygen consumption, ft per ton	1000 from air	1000 plus oxygen from air		2000	
Production increase over air blowing, per cent	...	15–20		15–20	
Slag Fe, per cent	11	12.5		12.5	
Converter lining life, blows	400	400		350	
Bottom life, blows	75	60		40	
No. of tuyere holes	200	200		100	
Diameter of holes, in.	0.55	0.55		0.55	
Scrap consumed, per cent	4.5	18		4.5	
Production rate, tons per min, 30-ton converter	2.0	2.8		2.8	
Production rate, tons per min, 50-ton converter	3.0	5.0		5.0	

BASIC BESSEMER

The major portion of the ores mined in Europe are phosphoric and the iron therefrom is largely allocated to the basic bessemer or Thomas steelmaking process.

In the conventional practice of blowing with natural air, the impurities of the molten iron charged with burnt lime and a small percentage of scrap are oxidized in the following order: silicon, manganese, carbon and phosphorus. After the carbon is practically eliminated, 90 per cent of the phosphorus still remains. The blowing is stopped at this time, samples taken and the phosphorus content estimated. The heat is blown again for a predetermined number of seconds to remove the phosphorus. During this period of after-blowing, the practically carbonless metal and the high temperature cause a rapid rise in the nitrogen content of the steel to 0.015 per cent.

Prior to the use of tonnage oxygen, one method of reducing the nitrogen content was to charge ore, roll scale and limestone instead of scrap for coolants and blowing on the cool side of metal temperature. In this practice, less air is required and the blow is shortened, affording nitrogen contents in the medium range of 0.007 to 0.010 per cent.

In recent years the availability of tonnage oxygen has brought about some important developments in the production of low nitrogen and low phosphorus steels which not only serve the purpose for commercial steel applications but extend the useful life of many Thomas steel plants as well.

One practice is to enrich air up to 30 per cent with oxygen and at the same time use some ore, scale and limestone in the charge in place of scrap—resulting nitrogen content ranges between 0.005 to 0.007 per cent.

Oxygen enriched air blowing is also used to promote higher metal temperatures and melt more scrap. This permits the melting of 15 to 20 per cent scrap and produces steel of slightly higher nitrogen—about 0.008 per cent.

In some cases it is desirable to blow with air enriched to 30 per cent oxygen for a period of time and finish the blow with steam and oxygen to produce lower nitrogen steel. About 15 per cent scrap can be melted and at the same time a steel of 0.004 per cent nitrogen is produced which is in the range of average open hearth steel.

Very special grades, such as deep drawing quality sheets and heavy plates for welded ship construction, are blown without nitrogen in the blowing gases. Air is wholly excluded and the entire blowing period is conducted with mixtures of steam and oxygen. The scrap addition is relatively small but a very low nitrogen steel of under 0.002 per cent nitrogen content is produced. With these special low nitrogen grades, a double slag process is employed to reduce the phosphorus to a lower level than 0.050 per cent that normally results with the use of a single slag. The blow is made in the normal manner after which some slag is decanted off and a soda ash addition made to the remaining slag. The heat is reblown for 15 to 20 sec and the phosphorus reduced to below 0.025 per cent.

Table I shows the phosphorus and nitrogen contents, the converter lining and bottom life, and the yields obtained with the various blowing mediums discussed.

TOP BLOWN BASIC OXYGEN FURNACE

The success with oxygen on bottom-blown vessels encouraged development along different lines. After experimenting with 2-ton converters and spurred on by the fact that in Austria the iron produced from Styrian ores contains less than 0.20 per cent phosphorus and is not adaptable to the bottom blown Thomas process, the pioneer installation of a full production top blown basic furnace plant was made at Voest in Linz, Austria. The process has more in common metallurgically with the basic open hearth than with the basic bessemer even though the converters and the plant layout are similar to a Thomas converter plant.

A substantial amount of operating experience has now been had with this process and as in North America relatively low phosphorus ores are abundant and the economics of capital investment are more favorable when compared to an open hearth installation. Interest and the number of installations are rapidly increasing in this hemisphere.

Today sufficient information of practical and theoretical value is available on this process and most persons interested in it are or can very easily become well versed in all its aspects. It will suffice to say the poten-

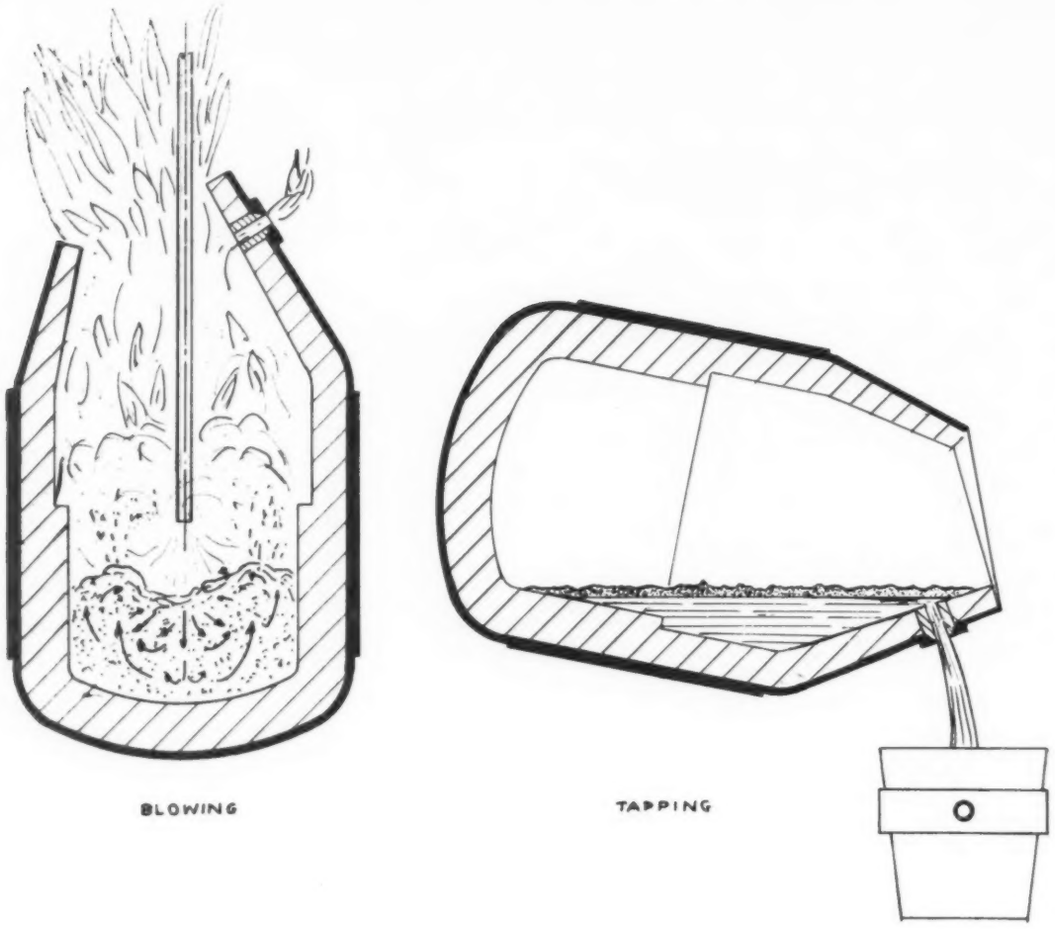


Figure 3 — Scrap charges approaching 35 per cent have been used in some shops and higher percentages are being investigated in some LD plants.

tial of this steelmaking process has advanced considerably but even so has not yet reached the ultimate in production rates and quality features. Those having installed LD plants are realizing the capacity of their individual vessel is greater than was originally estimated and steel production is being limited by the ability of the auxiliary units to feed raw materials to it and take away the finished metal. Production is exceeding 100 tons per hr and heat size is approaching rapidly to the point (estimated 160 tons) where the furnace design and tilting mechanism will have to be changed. Flexibility of hot metal analysis range and of the grades of steel produced is also greater than first anticipated. High carbon steels are being made regularly and experimental work on alloy steels is progressing.

Ore is now making up varying percentages of the charge with a savings in some situations resulting from the reduction of over-all cost of charged metallics and oxygen blown per ton.

Scrap charged, believed limited to 25 per cent originally, is now approaching 35 per cent in some shops. The use of high silicon iron indicates 50 per cent scrap melting may be achieved.

The LD process is now well established in this country and the low conversion costs being attained are dictating that increased steelmaking capacity will be LD rather than new open hearths and in some situations LD is replacing existing open hearth furnaces. The cost of materials is about the same for both the LD and open hearth processes.

SIDE BLOWING

All the processes so far mentioned have in common the oxidation of CO to CO_2 taking place primarily outside the vessel with a resulting loss of available exothermic heat that could be utilized to melt higher percentages of scrap. Burning carbon to CO_2 produces at least three times the heat of burning carbon to CO only.

Bessemer blowers have always been aware of this heat potential as evidenced by the practice of positioning the vessel more towards the horizontal plane during start up turns on cold vessels or whenever a cold heat was apparent. This was known as side blowing and a certain amount of CO was burned to CO_2 inside the vessel to increase the heat available.

Along with the greater heat, lower nitrogen contents also resulted because air entered at the slag-metal interface rather than being blown directly up through the entire bath of metal.

Specially designed side blown converters (Tropinas) have been used on a production scale, particularly in foundry work. Experimental work to produce low nitrogen steel from normal American pig irons by the side blown principle has been done with the turbo-hearth process.

KALDO PROCESS

One of the first methods employed on a production scale to take advantage of burning most of the CO

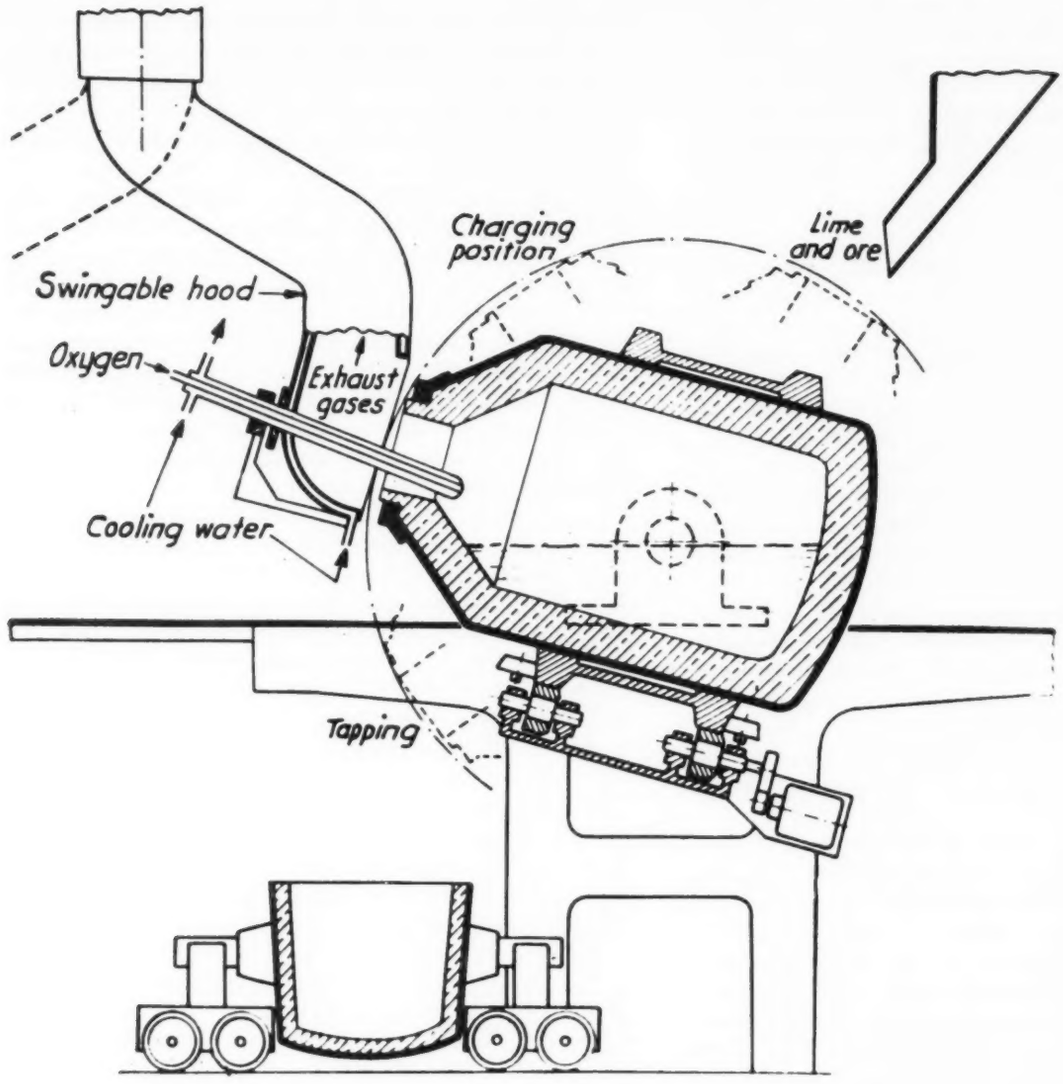


Figure 4—The burning of the majority of the CO within the Kaldo vessel substantially increases the thermal efficiency of the process.

inside the furnace along with the use of pure oxygen lancing is the rotating converter developed by Professor Bo Kalling and his associates and placed into full scale operation in May, 1956 at Domnarvet, Sweden.

A rotating concentric vessel of 30 tons capacity is being used. The vessel is inclined at 17 degrees from the horizontal so the melt will cover at least half of the back wall and it is rotated at speeds up to 30 rpm. The angle of inclination increases the productive capacity of the furnace and exposes more of the lining to the cooling effect of the metal during rotation. The high speed rotation provides a greater degree of slag/metal contact than does stationary converters. A basic slag is formed earlier than in other processes which promotes early and rapid elimination of phosphorus and at the same time there is a low loss of iron to the slag.

Measures and observations have been setup to provide means for good control of the blow. By varying the angle of the lance, the iron oxide content and fluidity of the slag may be increased or decreased as desired. The same effect can result by varying the speed of rotation—high speeds decrease iron oxide while slow speeds have the reverse effect. These techniques aid in regulating dephosphorization ahead of decarburization and attaining high charge to ingot yields.

The condition of the slag may also be estimated by the load on the rotation motors, as the load decreases with melting slags.

The temperature in the exhaust gas pipe can be related to the intensity of the boil inside the vessel and variations in the rotating speed at a constant oxygen flow can bring about more efficient burning of CO inside the furnace.

The process is flexible and by double and triple slag methods can handle extreme levels of phosphorus in the hot metal up to 2.200 per cent phosphorus. The scrap charge can be as high as 40 per cent with iron of sufficiently high silicon and phosphorus contents.

BASIC OXYGEN AND KALDO COMPARISON

A heat balance (Table II) indicates that the thermal efficiency of the Kaldo process is higher than that of

TABLE II

Process	Thermal efficiency, per cent	
Kaldo	75	Percentage of heat input retained as sensible heat in steel and slag.
Basic oxygen furnace	70	
Basic acid bessemer	55	
Basic open hearth	28	

TABLE III

Process	Metal yield, per cent	
Kaldo	90–91	Metallics charged to ingots.
Basic oxygen furnace	87–88	
Basic open hearth	84–85	

stationary converters and of course is considerably higher than other steelmaking processes.

Fume cleaning—Pneumatic processes, particularly with the use of oxygen, are confronted with the problem of air pollution and dust control.

The method of top blowing produces a great volume of dark brown fumes containing particles of sub-micron size necessitating an elaborate system of cooling, dust collecting and cleaning to enlarge and collect this fine material and discharge to the atmosphere an effluent gas acceptable to dust control regulations in thickly populated areas.

Since the CO gas evolved from the metal is burned to CO_2 within the converter, the volume of gas is lower which permits slower cooling for the formation of large particles and requires a comparatively simple dust catcher system to purify the waste gas.

Iron losses through waste gases amounts to 0.5 per cent in the Kaldo. Losses from the top blown process are 1.0 per cent.

Yields—Comparative yields of the Kaldo, LD, and the basic open hearth based on a charge of 70 per cent low phosphorus hot metal and 30 per cent scrap are given in Table III.

Flexibility—The utilization of the heat from the combustion of CO, combined with added controls allowed through varying lance angle and rotating speeds, permit greater flexibility in phosphorus analysis of hot metal and higher percentages of charge scrap in the Kaldo.

The top-blown basic furnace, however, is capable of producing satisfactory phosphorus levels with the normal 0.200 to 0.300 per cent phosphorus hot metal available in the U. S. and Canada. Also with higher silicon hot metal the percentage of scrap charged has reached well over 30 per cent.

Lining life—Kaldo linings, affected by the high speed rotation, average only 50 to 70 heats compared to approximately 175 to 200 heats with the top blown basic furnace lining. The refractories consumption averages about 20 lbs per ton for stationary converters which are considerably lower than the basic open hearth.

Those involved with developing the Kaldo in Sweden and the U. S. estimate lining life should be about 125 heats with an 18-in. or thicker lining on a 100-ton furnace operating with American type low phosphorus basic iron. Straight line production of low carbon steels where experimental slag and metal tests can be reduced to a few heats per day rather than on every heat should permit cooler blowing, reduce cycle time and less erosion of the lining.

Production—Tons per hour, tap-to-tap, have exceeded 100 tons in the LD process. The Kaldo production in a 100-ton vessel is expected to be about 75 tons per hour.

Installation costs—Installation costs of both the processes is approximately 50 per cent of that for an open hearth of equal capacity. The added cost of the rotating equipment on the Kaldo is offset by the less costly dust cleaning equipment required.

Chemistry—Both processes have the following chemistry advantages:

1. Carbon is eliminated at a very rapid rate, both by direct oxidation and by diffusion of iron oxide from slag to metal. With proper control, the iron oxide present is reduced by carbon as rapidly as it is formed.
2. The residual oxygen levels of 0.06 per cent carbon steels is about 0.04 per cent. This is lower than open hearth steels where the oxygen varies from 0.04 per cent at 0.10 per cent carbon to about 0.09 per cent at 0.04 per cent carbon. Further evidence of low oxygen content is the smaller aluminum additions required for deoxidation.
3. Residual Mn of the blown metal generally runs higher than open hearth steel. The residual Mn is influenced by the percentage of Mn contained in the iron. With 2.50 per cent Mn iron, residuals of 28 to 30 per cent are normal in low carbon steel.
4. Phosphorus is eliminated before carbon elimination is completed. No difficulty has been experienced in removing phosphorus to a level of 0.015 per cent with a single slag when blowing iron of under 0.250 per cent phosphorus content.
5. Sulphur removal is better than in the open hearth because of the generally lower iron oxide content, more intimate contact between slag and metal, hotter and more fluid slag, the elimination of fuel as one source of sulphur and the fact that some sulphur is burned off to the atmosphere.
6. The high purity oxygen employed as the refining agent contains very little nitrogen. The steel contains 0.002 to 0.004 per cent nitrogen when blown with oxygen of plus 99.00 per cent purity. This is well within the range experienced with open hearth steels.

NONMETALLIC CONSTITUENTS OF CONVERTER STEELS

There has been a persistent belief in some areas of steelmaking and usage that steel produced in converter

Figure 5 — Rotation of the cylindrical shell of the rotor process permits greater control of dephosphorization and temperature.

type vessels is a relatively dirty steel as compared with open hearth steel of similar composition.

In an open hearth heat during the carbon boil the rate of carbon elimination may be 0.5 to 0.7 per cent per hr and this produces a rather vigorous boil. During the vigorous boil the slag and metal come into intimate contact and are mixed quite thoroughly. The slag, however, does not become suspended more than momentarily in the liquid metal. Spoon samples taken at this time do not show slaggy inclusions in the metal.

In converter heats, either bottom or top-blown, the rate of carbon removal is greater than at any time in the open hearth and a very violent boil ensues with extremely intimate mixing of slag and metal. However, here again, spoon samples taken at the finish of the blow do not reveal any slaggy constituents in the metal.

In tapping an open hearth heat, the tap hole is below slag level and great care is usually taken to maintain a tap hole small enough to have the metal tapped first and the slag held back as long as possible. The ladle additions of ferro-alloys and deoxidizers are made before the slag appears, thus avoiding undue contact of slag and deoxidizers, loss of ferro-alloys and contamination of the metal with excess amounts of solid deoxidation products.

In converter practice the bottom-blown acid and basic converters have in the past used the practice of lip pouring of both slag and metal into the steel ladle. In acid practice the Mn is usually kept low in the iron so as to produce a stiff siliceous slag which holds back fairly well in the converter until most of the metal is tapped and the ladle additions made. In basic practice the basic slag is fluid and the usual practice is to decant off most of the slag and hold back the remainder by building a dam at the lip with additions of lime or cold crushed slag.

In the recently developed top-blown or LD process the converters are equipped with tap holes and clean metal taps are made the same as in open hearth practice and the steel is as clean as open hearth steel of the same composition. A tap hole is now being used in some bottom-blown acid converter shops, both in this country and in Europe.

The practice of full blowing bottom-blown converter steel to carbon levels considerably below the carbon specification has been an item of criticism of bessemer converter steels for many years. In the open hearth the practice is to catch the carbon on the way down to make a specified grade and avoid excess oxidation of the metal, heavy use of deoxidizers and excessive amounts of solid deoxidation products. The present day practice in LD or Kaldo oxygen blown converters is to also catch the carbon on the way down. There is no evidence or reason to believe that endogenous oxides formed in this manner are more prevalent in these converter steels than in open hearth steels of the same composition.

Exogenous inclusions arising from erosion of refractories in the ladle after the steel is tapped are the same for any steelmaking process. Reactions between ladle refractories fluxed with tapping slag and by reaction with Mn, Si and aluminum contents of the steel are a major source of nonmetallic constituents of steel regardless of the process of steelmaking employed, open hearth or converter steels.

Finally, there is no reason to believe these oxygen converter processes produce steel of higher nonmetallic inclusion content than open hearth steels of the same composition.

PROPERTIES AND USES

The ductility and impact properties are comparable with open hearth and the per cent elongation and Ericksen cap test values are in some grades slightly superior to open hearth steel.

FUTURE PROSPECTS

The success of the processes mentioned has stirred the imagination of metallurgists and other researchers to develop modifications.

Some of the more successful are:

1. The French process, known as oxygen lime-powder injection, uses the conventional oxygen top blowing combined with a specially designed top injector to introduce powdered lime at a variable rate. The advantages are: ease of dephosphorization from any initial phosphorus content, no foaming, reduction of red fumes, longer lining life and greater flexibility of hot metal analysis.

2. At Oberhausen, in Germany, a large cylindrical vessel, known as the rotor furnace, has been developed and was initially installed in a blast furnace casting bay to pre-refine the total cast of 60 tons of hot metal to about 1.0 per cent carbon before transferring to the open hearth.

Pure oxygen is introduced beneath the surface of iron by means of a water cooled lance and a less pure or secondary oxygen is also introduced above the surface to assist in burning more of the CO to CO_2. Like the Kaldo, the thermal efficiency of the process is high and the rotating principle permits more flexibility in slag/metal reactions and temperature control.

Steel is now being made by this process and a number of installations are being considered for operation in Germany and South Africa.

3. Other work continues to improve the technology and efficiency, such as preheating of scrap, ore injection and the use of hot blast cupolas as a source of hot metal.

4. Complete automation is a not too distant dream attested by the ability of present operators to predict the carbon level of the bath by the amount of oxygen blown.

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Discussion

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J. N. Albaugh and R. E. Edwards: After approximately 20 months of operation of the basic oxygen furnace plant at Jones & Laughlin's Aliquippa Works, the full potential of oxygen steelmaking in its' various aspects as compared to other methods has only been indicated.

The best example of this is the production rate although the same may very well apply to other factors such as yields and quality of the end product. The original conception of the basic oxygen process was a conversion rate from charge to refined metal of approximately two tons per minute. Through experimentation with lance nozzles and varying rates of oxygen flow this conversion rate can exceed five tons per min of lance time. Since the original plants were designed for handling materials and product at a much slower refining pace, many changes will be required to take advantage of this development.

Comparison of pneumatic steelmaking methods employing high purity oxygen, or combinations of oxygen and steam can be based only on results available at present. Evaluation of the basic oxygen, or LD process, will probably be accomplished earlier than some of the other processes mentioned in this paper by virtue of the numerous installations throughout the world, and the comparatively large number of personnel actively engaged in this type of production. In the final analysis various factors such as available raw materials, production requirements, and quality demands will determine the process best suited for any individual plant or geographical location.

While most of the industry has pretty much eliminated the manufacturing of bessemer steel due to the facts mentioned by Messrs. Yocom and Xidis, the process itself is still retained by companies such as Tennessee Coal and Iron at Birmingham, Ala., U. S. Steel Corp., at Gary and South Chicago, National Tube at McKeesport, Pa., and Jones and Laughlin at Aliquippa in the production of duplex steel. All of these shops were built on the premise of using the converter process with sufficient ironmaking capacity available. To abandon them and replace with straight scrap and hot metal furnaces would require the expenditure of large sums of money and more furnaces to make the same tonnage so all of the above plants have constantly figured out ways and means to maintain a high tons per hour figure, and produce a product which is as good or better in many cases than steel made from straight scrap and hot metal. Plants have developed ways of producing steels which are not too much higher in nitrogen content than the conventional open hearth product.

In the past year Youngstown Sheet and Tube has abandoned their bessemer plant which now leaves Wheeling Steel, using the process for making bessemer steel of lower phosphorus content as mentioned in the paper, Republic Steel at Youngstown, Ohio, National Tube at Lorain, and the Ohio Works of U. S. Steel Corp. as the only bessemer steel producers. All of these plants produce bessemer steel ingots to meet the demands of their customers. The Gary Works of U. S. Steel can also utilize their converting mill for making bessemer steel ingots to meet orders or peak demands for steel and our own plant at Aliquippa has continued to make bessemer steel.

The American steel industry never adopted basic bessemer practice since the U. S. was fortunate in having sufficient ore supplies of low phosphorus content, and does not have the high phosphorus ores necessary for this process.

The basic oxygen process was designed primarily for the production of steel for flat rolled products, however, practices have been developed that have resulted in the successful production of the high carbon and alloy grades, normally produced in the basic open hearth or electric furnace. It is certainly our intention at Aliquippa Works to continue to make bessemer steel to meet the demands of our customers, to produce duplex steels and to improve performance on basic oxygen steel which as of the moment produces steel at the fastest rate now known, with phosphorus, sulphur, and nitrogen content in line with metallurgical requirements comparable with any process now known.

C. C. Benton: In 1955, Algoma Steel Corp. was faced with the problem of increasing their steelmaking facilities, and the replacement of the obsolete No. 1 open hearth shop. The company was one of the many steel producers watching with great interest the Austrian developments with the new process of top blowing practically pure oxygen onto the metal in a conventional converter. Due to the economic possibilities and apparent flexibility of the process, Algoma investigated thoroughly the newly developed basic oxygen process as opposed to increasing its No. 2 open hearth shop capacity. Tests at that time showed that the basic oxygen steel was equal to open hearth steel in quality, and the companies' analysis of the process indicated that any grade of steel produced in the basic open hearth could be produced by the basic oxygen process.

Experiences with basic oxygen steelmaking largely confirm the authors' statements that the full potential of this process has yet to be realized, and that at present productivity is largely limited by the ability of the auxiliary units to feed raw materials to the furnaces and take the products, steel and slag, away from them. During the first nine months of operation 150,000 net tons of steel have been produced in the 0.10 to 0.30 per cent carbon range, and a further 50,000 net tons of steel have been produced over 0.30 per cent carbon, including various low alloy grades using the

catch carbon technique, so that in our opinion, the flexibility of the basic oxygen process for producing varied grades of steel has been well established.

During these nine months of operation considerable experimentation has been possible in the direction of heat size and charge composition. Our experiences in this field may be summarized as follows. The original furnace rating from the manufacturers was 60 net tons, allowing one cu meter of working volume per net ton of capacity, equivalent to 30 cu ft of working volume per net ton of ingots tapped on a newly-lined furnace. Heat size has been gradually increased to the point where on a newly-lined furnace, tapping approximately 99 net tons, there is 13.5 cu ft of working volume per ton of steel tapped. This is not suggested as a new design rating under all operating conditions, but it does indicate the trend in thinking throughout the industry. In the same way charge composition has been successfully varied between all hot metal/scrap charges through the full range of hot metal/scrap/oxide charges to full hot metal/oxide charges. At present the average charge is stabilized at 82.5 per cent metallics as hot metal, 4.5 per cent metallics as oxide and 13 per cent metallics as scrap. Our experiences indicate that there is a saving in blown oxygen consumption per net ton of ingots produced by replacing scrap by oxides.

We agree that because of their inherent higher thermal efficiency, the development of the Kaldo and Rotor processes demands close watching. However, at present for North American plants with low phosphorus hot metal, the top blown oxygen process offers the most advantages from the point of view of productivity, proven flexibility and lower refractory consumptions.

D. R. Berg: As a consequence of such constantly developing technology, very recent work at Domnarvet has produced results which might serve to supplement this excellent paper. With regard to thermal efficiency, the Kaldo process has recently been running at very close to 80 per cent. The 80 per cent figure is derived by dividing the sensible heat in slag and steel by total heat available, considering complete conversion of carbon removed from the molten metal to CO_2 as well as oxidation of other impurities. This has resulted in the melting of 47 to 50 per cent scrap during a number of heats in which iron, comparable to that generally produced in the U. S., was used.

These heats which contained a high percentage of scrap charge produced yields of approximately 92½ per cent.

Recent progress in lining life has also been made at Domnarvet. With thin working linings and high phosphorus pig iron, performance has been between 70 and 90 heats. As the direct result of work which is currently underway, their lining life will be 100 heats or more in the near future. This makes it reasonable to expect performance of 150 or more heats with the thicker linings that will be used in and are characteristic of larger furnaces in this country and with the iron charge containing much less phosphorus than the average of 2 per cent prevailing at Domnarvet.

Two new Kaldo plants will go on stream in Europe within the next 12 months. The plants have 110-ton furnaces. The performance of these units, together with developments at Domnarvet as a result of a recent program established to more completely evaluate the capabilities of the process, will be of interest to everyone. ▲

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

ROLL DESIGN and MILL LAYOUT

By **ROSS E. BEYNON**

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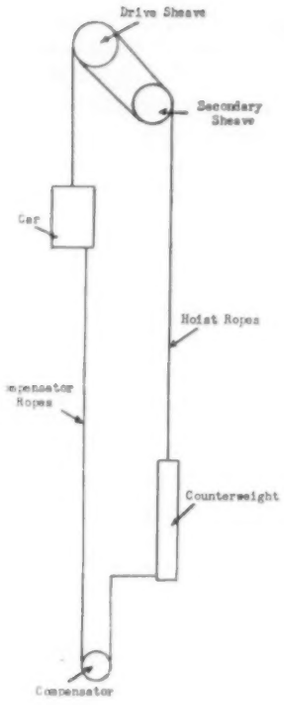


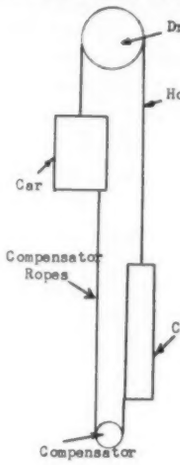
Figure 1 (left) — Elevator depends primarily on friction between the rope and the sheave groove.

Figure 2 (below) — Two typical sheave grooves.

V-Groove

Preformed Constant Traction Groove

Figure 3 (below) — Elevator drives may be either single or double wrap. This one is the double-wrap type.



U-Groove

Undercut U-Groove

Figure 4 (right) — Two other groove types are illustrated.

THE use of the traction elevator to replace the old drum machines in the elevator industry has contributed towards the rapid growth of the elevator industry. It has made possible efficient and safe vertical transportation since it has facilitated the use of a multiple rope system and for all practical purposes eliminated the hazard of raising the elevator car into the hoisting equipment.

The traction machine drives an elevator car, counterweight car ropes and rope compensation system by means of friction. It is amusing to witness the reaction of a layman when it is explained that a fully loaded car is held at the fiftieth floor by friction between a lubricated rope and a sheave groove, he starts looking for something to grab. Interestingly enough the fact that an elevator rope can slip in a groove is the source of the traction machines great safety record as will be described below. A typical traction elevator is indicated in Figure 1.

It will be noted that the single wrap elevator ropes simply rest in the grooves under the relatively high loads of the car and counterweight. The friction developed between the typical single wrap grooves illustrated in Figure 2 and the rope will raise or lower the elevator car. The unique feature of the traction machine is that should the elevator machine for some reason (say the failure of a limit switch) not stop the car at the top landing, the counterweight will bottom and the elevator will not develop sufficient traction to raise the car. This makes it impossible for an elevator car to be driven into the overhead structure. The most modern type grooves are preformed and are of the constant traction type illustrated in Figure 2. Figure 3 illustrates a double wrap traction drive wherein a lower traction groove is employed because the effective wrap is approximately 360 degrees.

The reasons for developing a good technique for the evaluation of elevator hoist rope performance are as follows:

1. The design of the drive and hoistway equipment of an elevator are primarily determined by the ropes because for a given elevator duty and tractive effort there is an optimum rope, sheave and groove combination.
2. The initial cost and maintenance of elevator ropes is a major expense.
3. The traction drive is peculiar to the elevator industry and the rope problems are specialized.

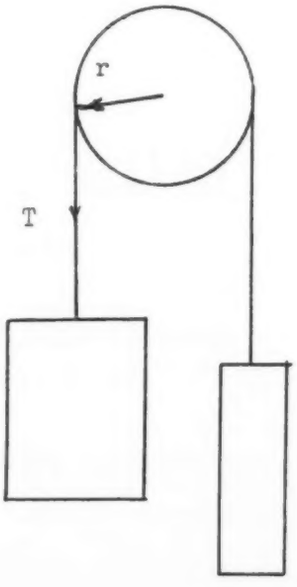


Figure 5 (left) — Rope erosion is a function of the bearing pressure and load.

Figure 6 (above) — Difference in tension on the two sides of the sheave depends on the acceleration.

Evaluation of Hoist Rope Performance

by H. BERKOVITZ,
Elevator Engineering, Elevator Div.,
Westinghouse Electric Corp.,
Jersey City, N.J.

No type of rope has perhaps had more study than elevator rope . . . material developed from these studies can be of help to other rope applications of which there are many in the steel industry.

4. The elevator manufacturers do not manufacture ropes but must be in a position to evaluate different types of cables.

There are many ways of solving a particular problem and choosing the most economical and efficient combination of drives, method of roping, sheave sizes, groove contours, sheave materials, lubricants, rope structure, rope materials, etc., requires both analytical and experimental study. Long experience with elevator ropes by those in the industry indicated the need of combining field experience, analysis and laboratory testing.

The traction phenomena is an extremely complicated one and in the final analysis field experience and simulated field conditions must be guiding. However, an analysis of the traction process highlights three guiding characteristics.

1. Groove pressure. If the sheave is considered to be a bearing, the sheave and rope erosion will be a function of bearing area and load, therefore:

$$p = \frac{T}{rdn} \qquad (1)$$

where:

- r = radius of sheave (in.)
- T = maximum static tension in the ropes in lb
- n = number of hoist cables
- d = rope diameter in in.
- p = nominal groove pressure in psi

See Figure 5.

If reference is made to Figure 2 and in particular to the preformed constant traction groove it will be seen that a further refinement may be obtained by determining the distribution of pressure in the groove which results from the greater pinching action. From the application standpoint the effect of bending will be automatically incorporated because larger sheaves mean lower groove pressure as well as lower bending stresses.

2. Traction ratio. The tractive effort required is a function of the passenger or freight load to be handled and speed of operation. In general, the higher the speed the greater the rate of acceleration. The traction ratio is the classical belt formula where:

$$T_1 = T_2 e^{(\mu\alpha/\sin\phi)} \qquad (2)$$

T_1 and

- T_2 = tension of ropes on each side of driving sheave in lb
- ϕ = angle of pinch
- μ = coefficient of friction of rope to groove
- α = angle of wrap
- e = natural logarithm base

A typical evaluation of T_1 and T_2 which includes the effects of acceleration will allow for the fact that when accelerating the moving masses the acceleration forces will add to one side and subtract from the opposite side. There are many combinations depending upon the application, but for illustration (Figure 6) a typical evaluation of the traction ratio is indicated below if T = traction ratio, a = rate of accleration in ft per sec^2, g = 32.2:

$$T = \frac{T_1[1 + (a/g)]}{T_2[1 - (a/g)]} \qquad (3)$$

3. Creepage. The phenomena of creep is present in a traction drive which is transmitting power. Analytically the hoist rope is a spring which will elongate an amount which is proportional to the static tension multiplied by an acceleration factor and factor proportional to the spring constant of the rope. An analysis of Equation 3 will indicate large differentials between the

Figure 7 — Rope testing machine shown simulates field conditions.

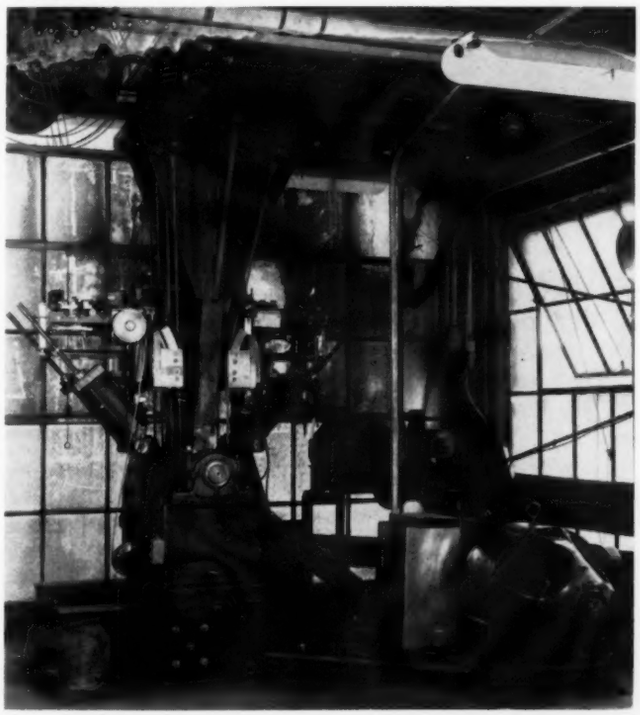


Figure 8 — Typical sheave test specimens have traction grooves machined with a predetermined radius of curvature.

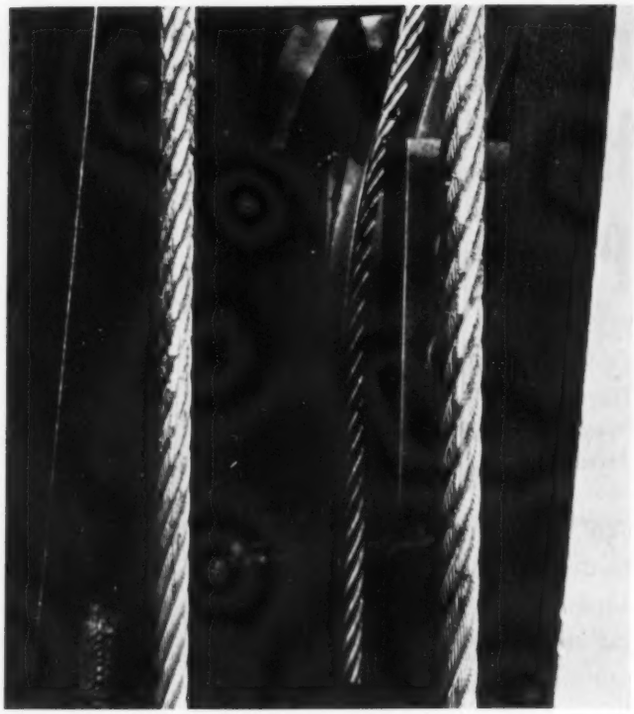


Figure 9 — Results of testing machine simulate wear obtained in the field.

dynamic tensions. For higher speed elevators T will be approximately 2. It is apparent that as a rope travels across a sheave there is a continuing creep in the direction of the unbalanced load as an elevator is transmitting power. There is good reason to believe that the energy of creep per inch of rope is a good criterion for evaluating performance. It may be technically more accurately termed the differential strain energy.

It is of interest to note that there is a radial creepage due to the deformation of a rope as the rope enters the groove, as well as a relative movement of one rope to the other due to differentials in tension and diameters.

The importance of, in some way, incorporating relative movement between a sheave and the rope is apparent.

The great emphasis on the stresses due to contact (Hertzian stresses) in the literature on ropes in recent years as well as general theories of loss of material confirm the importance of in some way giving important consideration to the creep phenomena.

To evaluate elevator rope performance is a complicated problem because the life of ropes must for economic reasons be relatively long. In addition, any testing method which simulates the actual lifting of a load by a machine is time consuming and expensive. A method was needed which would permit a relatively rapid evaluation of a combination of factors, which after screening would be tested in the field.

The rope testing machine illustrated in Figure 7 was designed to simulate as closely as possible field conditions encountered on elevators. To accelerate the test procedure it was decided to test a relatively short section of rope but for control purposes test a number of separate specimens. Typical sheaves were selected as received from the foundry and checked metallurgically and then sectioned. Reference to Figure 8 indicates typical sheave test specimens. A traction groove has been machined into the specimen with a predetermined radius of curvature. The rope specimen is fastened to a T-frame (Figure 7) and the base. The rope specimen is placed under tension by means of calibrated springs to a predetermined tension. It will be seen that there are two sets of springs on the T-frame which load up two sets of rope specimens and these sets of rope specimens are bent by the oscillating T-frame around two sets of sheave specimens by a means of crank driven by an accurately controlled motor. The test machine is balanced. The rope specimen is under both bending, tensile and bearing loads.

To obtain the relative creep movement present in the traction process outlined above, each set of sheave specimens is mounted to a carriage which will be driven both upward and downward a given increment for each bend around the sheave. The sheave specimen moves upward by small increments a predetermined distance across the face of the rope and will reverse automatically. In this manner the rope will be subjected to a simulated frictional loss which is proportional to the energy of creep mentioned above. The rope is not permitted to turn so that the results will be uniform. Counters are placed on the carriages to keep an accurate count of the number of passes the carriages move across the face of the ropes, and are also placed on the T-frame to count the number of bends.

Dynamic and static coefficient of frictions can be ob-

Figure 10 — Amount of erosion is obtained by making prints with a special pressure sensitive tape.

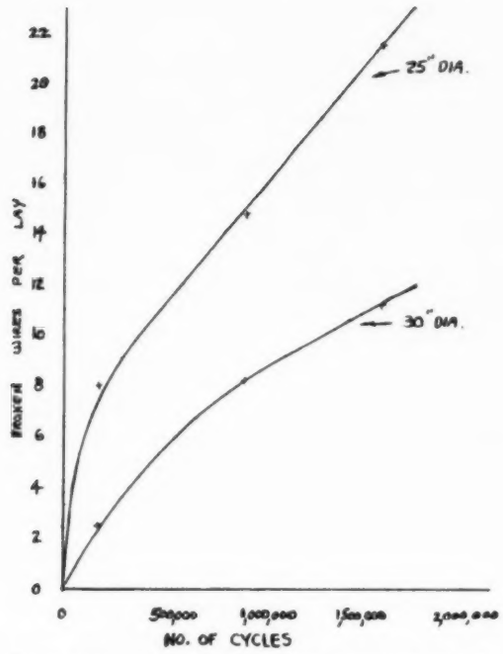


Figure 11 — Curves give the number of wire breaks per lay as a function of the diameter.

tained by providing springs at both ends of the rope specimen. The differential in spring deflection during the "creep" action indicates the tractive effort for a particular of wrap.

The type of rope erosion and wire failure obtained by the testing machine closely simulates the wear and erosion obtained due to field wear. See Figure 9.

To correlate the data meant developing a method of analyzing the test data. Test specimens are checked at specified intervals for the amount of erosion, number and type of breaks. The amount of erosion is obtained by making prints (Figure 10) of a rope at certain intervals with a special pressure sensitive paper. Tables have been prepared which permit calculation of the actual loss of metal. Records are kept of rope diameter and elongation and the strand nicking is checked at the completion of each test. Use is made of a standard type rope, sheave specimen, groove and load as a standard of reference for each group of tests. Each sheave specimen is checked metallurgically.

Typical results, in general, have paralleled the results obtained in the field. The laboratory results are in general more consistent because the number of variables are under closer control.

It is important when applying the data of this report to various constructions and applications to realize that the first series of tests were of a fundamental nature. The characteristics which were investigated were the effect of the use of several materials, diameters, the effect of lubrication and the effect of preforming (see Figures 11,12,13,14, and 15).

Field experience would indicate that this data could be applied and correlated for other constructions. In particular, when applying the data in the steel industry, it will be noted that the data presented is all on 6 x 25 or 6 x 19 filler wire construction which is commonly used on rigging and excavating cranes. An indication of the results to be obtained with the 6 x 37 construction would be to multiply the number of breaks obtained with the 6 x 19 construction by the ratio of the

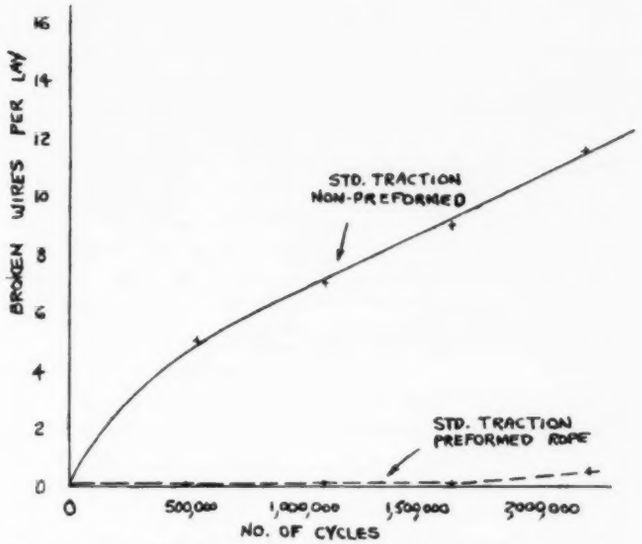


Figure 12 — Tests indicate that preformed rope gives much better performance than regular rope.

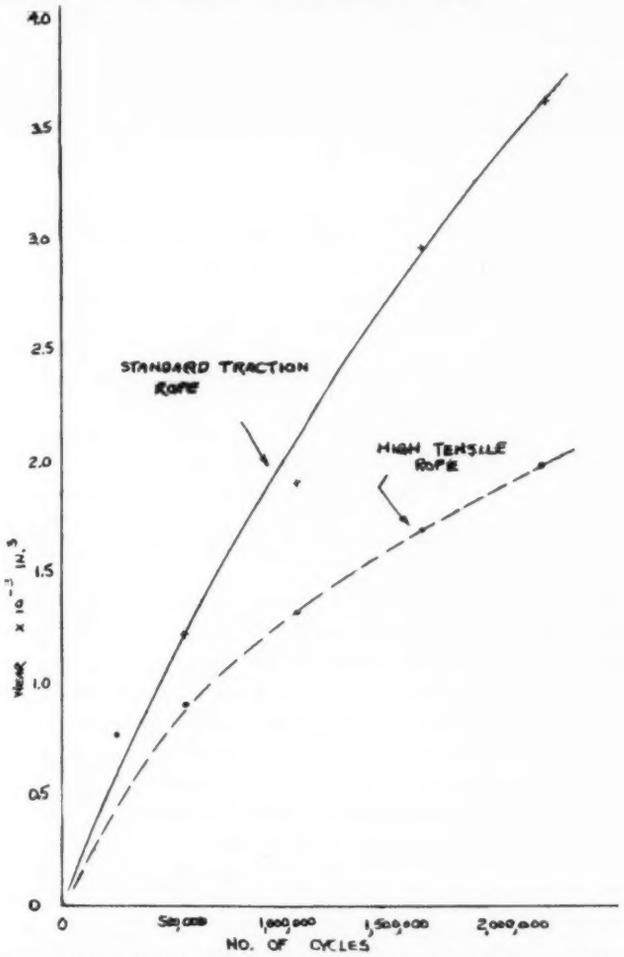


Figure 13 — High tensile rope shows less wear than standard traction rope.

outer wires of the 6 x 37 and 6 x 19 which would be 108/72 = 1.5. The ratio of reserve strength would be 58/43 because the reserve strength of the 6 x 37 is higher than that of the 6 x 19. The reserve strength is the strength remaining assuming loss of all the outside wires. It therefore follows that a somewhat higher percentage of outside wire breaks would be permissible with the 6 x 37 construction.

Figure 11 illustrates the number of wire breaks per

TABLE I

Car →	1	2	4	5
Cable construction	½ in., 8 x 21 filler wire non-preformed	½ in., 6 x 19 filler wire non-preformed	½ in., 8 x 19 seale, preformed	½ in., 8 x 19 seale, non-preformed
Maximum broken wires per lay	11*	12*	0	19**
Car miles	19,680	21,910	22,180	22,280
Miles per ft of travel	127.8	142.1	143.9	144.7
Total stops	1,924,126	2,153,330	2,029,548	1,928,447

* Breaks were found localized on one rope.
** Broader distribution of broken wires.

lay as a function of diameter. The ropes tested were 1/2 in., 6 x 25 non-preformed traction steel under a load of 1450 lb. The curves are the average of four specimens for each size of sheave. The sheaves were tested with a preformed constant traction groove illustrated in Figure 2. It is seen that the breaks per lay for a 30 in. diam sheave are approximately one-half the breaks per lay of a 25-in. diam sheave at the 1,000,000 cycle point. This test has since been for all practical purposes duplicated. There has been a question whether in the range of sheave diameter to rope diameter ratios of 50 to 60 there were significant changes in rope life. It is noted that with sheave diameter to rope diameter ratio of 60 the increase in rope life is significant. The slope of the wire break curve has flattened materially. Also note the further increase in rope life obtained by referring to Figure 12.

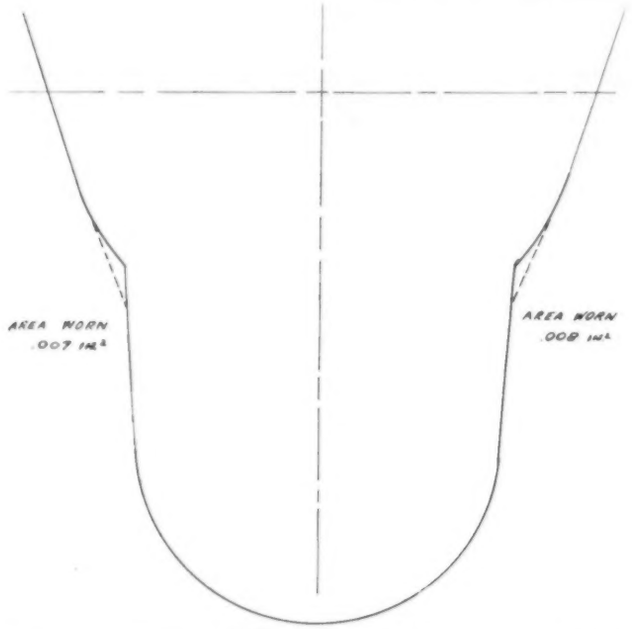


Figure 14 — Section shows point of worst wear in sheave used with periodic lubrication.

Figure 15 — Cross-section of point of worst wear shows much greater wear for rope tested with no lubrication than that indicated in Figure 14.

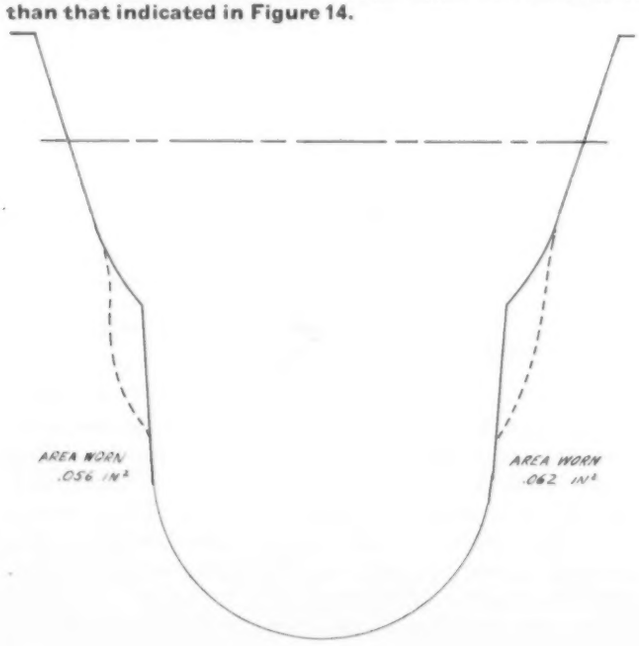


Figure 12 compares the performance of preformed and non-preformed standard traction steel rope. The ropes were 1/2 in., 6 x 25 traction steel rope under a load of 1450 lb. The sheave specimens were grooved with the preformed constant traction groove illustrated in Figure 2. The fatigue resistance of the preformed rope has been consistently better than the non-preformed rope. Field tests, as well, indicate that the fatigue resistance of preformed rope is considerably better than non-preformed rope. The full comparison of field and laboratory data remains to be made. A typical field installation upon which stop counters and mileage recorders were placed is shown in Table I. The number of bends at the point of maximum erosion and breakage is estimated to be about 800,000. It can be seen that the laboratory data parallels the field data. The results are an indication of the relative performance of preformed and non-preformed rope. Further tests are in progress. It should be noted that the erosion of the rope will become a significant factor in increasing the number of wire breaks as the number of operations are increased.

Figure 13 illustrates the comparative erosion of a standard traction elevator rope and a high tensile rope (improved plow). The loads on the rope were 1450 lb and the sheave materials and grooves were identical. The improved plow steel rope shows considerably less abrasion. Field experience with improved plow steel ropes has shown a parallel reduction in abrasion.

Figures 14 and 15 illustrate the marked difference in sheave wear if the rope is not lubricated. All lubricant had been removed from the strands and the core. The sheave volume removed for the unlubricated condition is almost eight times the sheave volume removed for the lubricated condition.

An analysis of the data shown above indicates that the technique evolved tends to be confirmed by field experience but permits a far more rapid and reliable evaluation of a given set of conditions. ▲

Equipment Maintenance Symposium

. . . . the ingenuity of the maintenance man can be an important tool in modernizing steel plant equipment . . . .

"SHOP METHODS AND TECHNIQUES EMPLOYED TO IMPROVE EQUIPMENT"

by VICTOR E. HOLTSLANDER
Assistant Superintendent, Electrical Dept.
Inland Steel Co.
East Chicago, Ind.

THE word, maintenance, seems to act as a tonic, to any man entrusted with the upkeep of equipment, whether served in large or small doses, and the topic is an engrossing subject that is never lacking in interest. Evidently there are many reasons why a discussion on this subject, appeals to men, entrusted with the continuous operations and availability of the apparatus that keeps the wheels turning in the iron and steel industry, or any other industry for that matter.

In this paper the author will give a brief résumé of his plant, and the vital part the electric shop plays on the maintenance team which is so necessary, to keep a program of this nature functioning and operating successfully.

Inland is an integrated steel producer, having its own coal, iron, ore and limestone mines and the usual blast furnaces, coke plants, open hearths, blooming mills, and mills to roll structurals, beams, bars, plates, hot and cold rolled strip, tin, merchant mills, galvanizing lines, etc., together withall the necessary warehouses, finishing and auxiliary equipment and shops to make a well-balanced plant.

To keep these wheels in motion there are in service some 28,000 motors, varying in size from instrument motors and desk fans through 16,800 hp, both alternated and direct current in all voltages to 13,800, as well as all the allied equipment such as, controls, wiring, brakes, magnets, lighting, etc.

The preventive maintenance program for the electrical equipment evolved gradually over the past 30 years and is still being improved.

All motor frames and armatures are assigned Inland numbers, records are kept by the electrical foreman in the mill and also the electric shop, as to the location of each unit and every change that takes place.

Routine varnish schedules are issued yearly through the electrical department office, tabulating the units to be varnished during the coming year, and sent to the respective electrical foremen in the mill. He in turn contacts the production people to schedule these changes.

Frequency of maintenance service is determined basically by the place of the motor in the production operation. Together with the scheduling of these changes in the mill, the scheduling of these units through the shop becomes a great problem. At present we try to service about 100 motors per week through the shop; in simple arithmetic that is only a total of about 5000 motors per year, or a period of nearly six years is required to have every motor in the shop at least once. This includes planned changes only, and does not include any failures which occur. Therefore shop planning, scheduling, standardization, methods, techniques, stabilization of inventories, parts control, etc., are but a few of the critical problems confronted by the shop of today.

A constant reevaluation, readjustment or redesigning (if you please) of equipment and parts, are so necessary to incorporate the same internal motor part to as many units as possible regardless of the manufacturer. Each piece of apparatus, or part going through the shop has a definite routine, or test, or operation which has been adopted as a standard that must be carried out before it is ready for service again. Most of these methods and changes were made possible by changing nothing but complete motors before they fail, thereby actually seeing the causes of failures developing in their initial stages, then endeavoring to apply methods to prevent a reoccurrence. After a motor fails or is badly burned out, most of the evidence is usually not available.

Following are several examples which illustrate this point of parts standardization and inventory control of parts graphically.

Mill type motors—

1. There are the 1915 to 1930 vintage—known as the 100 series motors or its equal. Hundreds are still in service.
2. Then came the 1930 to 1940 vintage—known as the 400 series or equal.
3. There is now the 1950 vintage—known as the 600 series motors or its equal.

Each of these vintages has from 10 to 12 sizes ranging from 5 to about 300 hp. This adds up to some 35 or 40 different motor types per manufacturer, and there are several manufacturers of these mill type motors. Therefore in the mill type motors alone, we may have from 75 to 100 motor types, each requiring entirely different parts. From this one can readily see the necessity of shop standards regardless of manufacturer.

For example, how many parts are necessary to renew such minute parts as brush holder studs? Well it would require an inventory of over 300 different parts for this line of motors alone.

Let us illustrate what has been done to overcome this. We have worked up molded polyester insulated steel studs. In one case we use one type stud on 19 different types of mill type motors. This alone reduces the parts inventory from about 75 to 1 part, plus a tremendous reduction in assembly cost, also procuring a much better type insulator. This just about eliminates the possibility of grounded brushholder studs.

A number of years ago the spring and finger mechanism of all our brushholders was redesigned. At that time it was common practice to have the finger mechanism operate through a bearing surface on the barrel. Frequently motors would arrive at the shop with the brushholder finger frozen to the barrel, due to current being carried through these bearing surfaces. When this occurred, no tension could be applied to the brush, resulting in poor commutation and eventually a burn out. To overcome this, all bearing surfaces and moving parts were eliminated; all that is used is the barrel, a spring, and a pin or screw. All these parts are secured rigidly to the frame of the brushholder, all movement being in the springs only.

Springs are procured from a spring manufacturer in the district, and one spring may fit 15 or 20 different types of brushholders, as does the barrel. The flat clock type springs, rather than the wire wound type, are favored and wherever possible this is used. These springs are made heavy enough to carry the current, should the brush pigtail deteriorate. This too has reduced assembly costs and inventory of brushholder parts in about the same proportion as mentioned above, and also definitely improved commutation.

On general purpose machines a standard brushholder which uses only three parts was also designed, and these same parts are used on a number of sizes. In another example, regardless of the manufacturer, if the motor requires a brushholder with a ½ × 1-in. brush the standard holder of this size is used, and this same procedure follows through on most all sizes.

Can you conceive the number of not only parts, but the complete brushholders of all the different types and frame sizes of all the manufacturers of general purpose motors this standard brushholder replaces?

On these motors we have also wherever possible replaced the metallic brushholder rocker arms, together with the hundreds of styles and sizes of insulating washers, tubes etc., with laminated plastic rocker arms. This also eliminates grounded brushholders and studs. This again affects assembly costs and parts as mentioned heretofore.

On field coils, each vintage of motor has a different method, and each manufacturer has his own methods on such items as coil terminals, wiring methods, securing coils on pole pieces, in frames, etc., using plates, springs, boxes, etc.

We have adopted a standard terminal for all field coils as they are rebuilt in the shop. On all field coils, manufacturers terminals have been removed, a copper conductor usually about twice the size of the field winding is brazed to the end of the turn of the coil, and allowed to project beyond the end of the coils thus making a rigid terminal. These are drilled to accommodate at least a ⅜-in. bolt, and wherever possible a ½-in. bolt. Lugs are applied to all internal motor leads and bolted to these terminals. With this method a good tight connection between the field coils and motor wiring is assured, this also eliminates all special terminals, sleeves, screws, small bolts, etc. To overcome the springs, plates, boxes etc., used by the manufacturer to retain the coils in the frame, asbestos sheet packing is used, employing a plate on the pole tip end only. Enough liners of packing are used to completely tighten the coils in the frames.

BEARINGS

The older babbitt, oil ring type bearing motors, both mill type and general purpose, are being converted to anti-friction bearings by using standard changeover parts. This is being done as rapidly as the shop program permits.

We favor, and have standardized on, the type bearing, which has the lip on the inner race to govern armature end thrust. Wherever possible we use this as a replacement for present anti-friction bearing installations also. This eliminates the end thrust, brass washers, steel thrust collars, pins in the shaft, bearing retaining nuts and washers, and threads on shafts which are always a potential breakage point.

As an example, on traction type motors originally employing rigid type ball bearings pressed on the shaft, and held in place with the usual nut and lock washer arrangement, no armature end thrust is possible. Usually these motors have large diameter flange type bearing housings, with the outside diameter machined to fit into the motor frame. Therefore any misalinement is directly reflected to the bearings, also during the disassembly of the armature, special jigs, studs, pullers, etc., are required to remove these bearings and housings from the shaft, plus many manhours of labor. On traction type air compressors there have been practically the same problems.

With the co-operation of the bearing changeover supplier, we have employed this type bearing on all such type installations and have eliminated all nuts, washers, threads, disassembly and reassembling labor costs, alinement problems (as this allows armature end thrust), and the most important item is that we have gained continuity of service of this equipment.

ARMATURES

The armature of rotor being the revolving member of a motor, not only presents one of the greatest problems for a preventive maintenance program, but also for the design engineer, and for the electric shops when rewinding or rebuilding is necessary. Few have any idea of the additional problems encountered with the introduction of higher temperatures, and the attention that must be given to such items as proper insulations, varnishes, banding, soldering, mechanical design, etc.

Nearly all electrical insulations contain some organic materials which are affected by heat in relation to time and temperatures. Heat causes a lowering of dielectric and shrinkage to insulation, which allows windings and banding to loosen, solder to flow from commutor risers and bands, the accumulation of these results in winding failures.

It therefore becomes necessary that the highest temperature insulations obtainable are chosen to suit the job, together with proper varnishes and methods as they are developed.

From operating experience it is known that one of the greatest causes of motor failure is banding wire. For a number of years the aim has been to eliminate as many bands as possible. About thirty years ago, the use of core bands was discontinued wherever possible, substituting a special bronze clip, which is inserted in the laminations and tightened. This requires all new motors and replacement laminations to be purchased with laminations punched for retaining wedges, and has been an Inland standard for years. Although this has been a problem to the manufacturers, it has paid dividends for Inland Steel Co. Through all the years the metallic end bands were still a major problem, even though special banding methods on major equipment were developed.

However, the development of polyester glass tape as a replacement to the remaining metallic bands in our motors has stimulated considerable interest.

After a prolonged trial period of glass banded armatures actually in service, we were convinced this material has *helped* solve the banding problem, and for the past several years most of our armatures have been banded with polyester glass tape. As of today there are hundreds of these armatures in service with excellent results.

A short time ago, we placed in service a glass banded, 2500-kw, 600-volt, 500-rpm, d-c generator armature, which is about eight feet in diameter. The bands are 8 in. wide. This armature was originally banded with a double layer of No. 8 steel wire. We now have three of these glass banded armatures in service.

This nonmagnetic tape has successfully replaced soldered steel or bronze wire and their underlying insulations. Since this tape forms a nonconducting system, there are no circulating currents in the banding itself, and there is no need for any insulation under the band. When higher temperatures are attained in the windings, there is no solder to melt out, or band insulations to deteriorate resulting in band damage or loss, which in most cases not only wrecks the armature but also damages the field windings, or other machines.

The cost of the tapes and their application, are far less than the traditional method of banding with soldered steel and its underlying insulations. This tape bonds itself together after twenty minutes at 125 C with complete cure effected after baking three and one-half hours at 125 C.

If too much of this tape is applied, after curing it becomes so hard it may be machined in a lathe, similar to a piece of steel.

On fractional horsepower motors, we have standardized on 3-phase, 440-volt, a-c motors, and 250-volt, d-c motors in the ¼, ½ and ¾-hp sizes, with mechanical interchange ability between the a-c and d-c units. These motors are used on water coolers, fans, machine tools, etc., or wherever fractional horsepower motors are required.

BRAKES

There are a number of brakes which had a brass plate that was retained in the case by a number of brass screws. Through the thousands of operations of these brakes the screws would wear and sometimes break. This necessitated difficult redrilling and tapping operations, also allowing the brass plate to loosen and fall from the coil case. When this occurred the coil would loosen and vibrate in the case, usually resulting in coil failure in a short time.

If the brake was on a crane trolley, the falling plate created a very serious safety problem which had to be corrected. To remedy this, all brass plates were eliminated by securing the coil in the case with an epoxy resin compound which cures atmospherically in about three hours. This also eliminated the remachining operations. This compound does not crack or become brittle and holds the coil rigidly in the case. This has practically eliminated burnouts as well as correcting a very serious safety problem.

MAGNETS

Unlike a motor or control, the magnet has no rotating or moving parts, nothing to wear out, no arcing parts, requires no lubrication except a little grease on the chains occasionally (and this is very essential). All of this may lead to the belief that a magnet requires little or no maintenance. However, well founded this supposition may sound, it is erroneous.

Lifting magnets can be one of the greatest shop cost items as well as one of the most abused pieces of equipment in the steel mill. They are used as battering rams to pile steel, remove stickers from ingot molds, etc., resulting in breakage and loosening of parts, due to lifting through the top cover. Yet in most cases this so called abuse is vital to the operation of the particular department.

To combat this on 29-in. magnets, we flame cut a square outerpole shoe from an 8-in. slab, this being machined for the coils and cover. Lugs are welded to each corner, and the magnet is lifted from four points of the outer pole shoe. On duplex magnets, used for slab handling, we also flame cut an outer pole shoe from an 8-in. slab, this also being machined to accommodate two 29-in. coils and covers. The lifting device consists of a 6-in. shaft supported through steel trunnions welded to this outer pole shoe.

On 65-in. magnets through the co-operation of the manufacturer we developed the present basket type

magnet for skull cracker, mold yard and scrap yard service. This eliminates lifting the magnet and the load from the top cover and relieves all pressure on the cover bolts. For about ten years we have followed the above procedures and have yet to break a ring or have a loose magnet case. In repairing and rebuilding we use nothing but mica disks and cones in all magnets. At present we are working with the manufacturers on an 1100 F mica insulation.

In conclusion we wish to mention that no offense is directed to any of the electrical manufacturers for changing and improving their lines of motors and equipment. However it must be remembered that with each succeeding or replacement line of equipment, a complete new complement of parts must be added to an already overburdened inventory, as the older equipment still remains in service.

The illustrations and items mentioned in this paper are but a few of the things which have been done and must be done in the shops of today, to minimize maintenance costs and delays. This not only reduces costs in your own department but the cost involved of processing each order for each part ordered handled and stored through the regular channels and departments of the company.

We are in business to make money by the manufacture of steel. One sure way to accomplish this is for electrical and maintenance engineers to maintain and keep the electrical equipment at the highest operating efficiency, and the electrical parts inventory to a minimum. In order to achieve these goals, members of the electrical department and shop, must be consistently on the alert seeking new methods and techniques, to keep the mills free of electrical delays, with the ultimate goal being, to do a job, better, faster, and at less cost.

Discussion

PRESENTED BY

L. A. TERRY Superintendent Power and Electrical Dept., National Tube Div., United States Steel Corp., Gary, Ind.

V. E. HOLTSLANDER, Assistant Superintendent, Electrical Dept., Inland Steel Co., East Chicago, Ind.

R. WINTERRINGER, Assistant Superintendent, Electrical Dept., Republic Steel Corp., Chicago, Ill.

C. E. SIEGELIN, Plant Electrical Engineer Wisconsin Steel Div., International Harvester Co., Chicago, Ill.

L. A. Terry: Have you used silicone varnishes to increase the rating of electrical windings?

V. E. Holtslander: We have not been in a position to enter the silicone field as yet because the ovens in the present shop are not arranged for high temperatures. A new electric shop which will have ovens with temperature ranges suitable for curing silicone is under construction. When these facilities are available we expect to use silicones, but will proceed with caution when entering this program for there are certain problems which presently exist and should be corrected. Silicones have a definite place in the insulation field and certainly can be considered to increase the ratings of electrical windings.

R. Winterringer: You process about 100 motors per week in the shop. About how many spares do you have available for each type motor?

V. E. Holtslander: We have no spares, they are replacement motors. Since we have some 25,000 motors in service, you can readily visualize the necessity of having replacement motors to assure continuous mill operations when units are removed from service for preventive maintenance or a failure.

When motors are removed from service for preventive maintenance they are sent to the electric shop where routine checks and tests are made to all parts of each unit as it proceeds through the shop. The motor is then reassembled and a complete test is made on bearings, end play, polarity, ground, short, neutral, brushes sanded, test run, speed, etc., before it is returned to the mill from whence it came.

This program has definitely reduced motor failures, rewinds, costs, length of time in shop and most of all mill delays.

Large major mill units are cleaned, checked, varnished and reassembled on location.

C. E. Siegelin: How are epoxy resins applied to brake coils?

V. E. Holtslander: Several years ago at a visit to one of the motor manufacturers factory, it was seen they were trying a perma-fill compound in their field coil manufacturing. We procured some and applied it to our brake coils. This is a two unit material which uses a catalyst and a powder and requires a temperature of about 150 F for curing (curing time and temperatures are critical), additional handling, etc.

A short time ago a potting type epoxy compound which cures atmospherically was found thus eliminating all baking time and handling.

This material is applied by setting the coil case in a horizontal position, placing the coil into the case and pouring the compound over the coil until the case is filled. This requires about three hours to cure. When cured it becomes very hard, does not crack or pull away from the case or coil. When coil removal is necessary it must be cut from the case with a chisel. However, we are not concerned with the removal of burnt out coils. The problem has been to retain the coils rigidly within the case to prevent burn outs.

This material has eliminated the brass plates and screws, and reduced brake coil failures to a minimum. Recently continual operation of the brakes has given the problem of the case wearing which necessitates welding and machining. A method of doing this with the coil and epoxy remaining in the case has been used.

"TIME SAVINGS FEATURES FOR MERCHANT MILLS"

by JOHN S. WYSOCKE

Assistant Plant Electrical Engineer

Wisconsin Steel Div.

International Harvester Co.

Chicago, Ill.

A GREAT deal of publicity has been given to automation and progress in manufacturing methods. It is quite evident that there has been a gradual evolu-

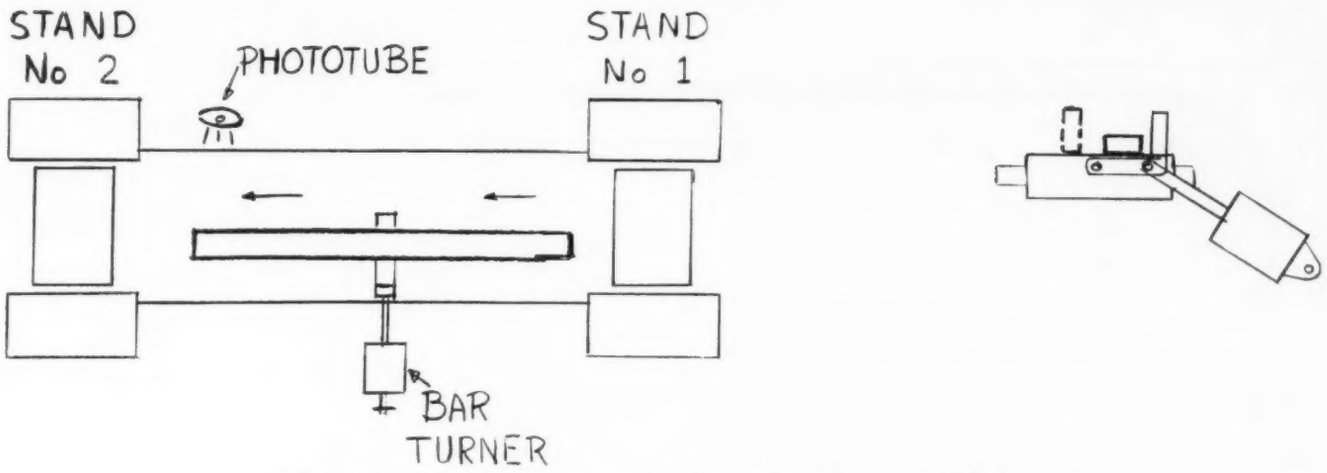


Figure 1 — The bar turner is essentially an electro-pneumatic device.

tion toward more automatic production ever since machines were first invented. This has resulted in a constant drive to find better ways of producing goods with less human effort.

To all of us, automation is indicative of something representing progress. Technically speaking, automation may be considered as the latest stage in mechanization. If you accept as a definition for mechanization, *the replacement of human power with machine power,* then perhaps automation may be considered as being *the replacement of human control of production processes with automatic control.*

Time saving items are a combination of mechanization and automation. At Wisconsin Steel, automatic control has been used at various stages of the rolling process. A partial list of the devices follow:

1. Bar turners.
2. Repeater.
3. Screw Box and switch pipe.
4. Hydraulic shear control.
5. Cone roll shifter.

BAR TURNER

The bar turner is probably the most simple of time savings gadgets in use. It is essentially an electro-pneumatic device which is operated by a photo-electric relay.

When the eye sights a hot billet the relay will actuate an electrically operated air valve which operates a piston. The piston then moves and operates the bar turning device.

As long as this eye is energized, the bar turner will remain in the same position. When the end of the bar passes the eye, the relay becomes deenergized, and moves the piston and bar turner back to the normal position.

There is no need for the bar to be stopped and turned since the bar can be turned while it is in motion. This not only saves time but permits closer spacing of bars through the mill.

REPEATER

The repeater is a device to direct the steel from one roll stand to another. Its function is to take the place of a catcher. The operation of the control of the repeater is quite simple:

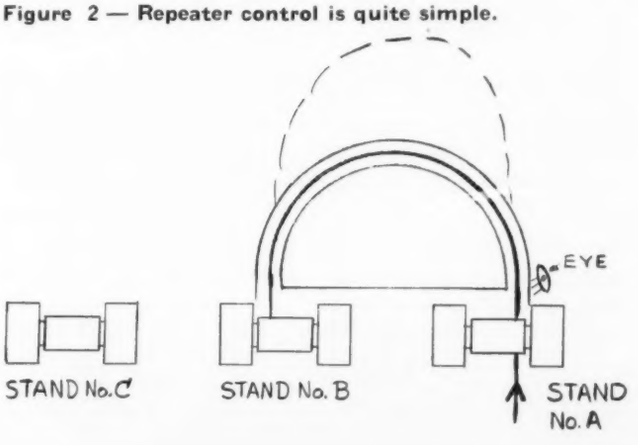
1. The electric eye which is located on the exit side of the roll stand sights the bar and starts a timing cycle.
2. When the bar enters the following roll and at the end of the predetermined time cycle, an electrically operated air valve raises the repeater and permits the bar to loop out.
3. When the end of the bar passes the eye, a second time cycle begins. This time is such that when the end of the bar just enters the radius of the repeater, the electrically operated air valve lowers the repeater in position for the following bar.
4. The seconds saved by this operation not only permit faster rolling, but also a hotter bar at the hot bed.

SCREW BOX AND SWITCH PIPE

The screw box is a method of opening and closing the guide box to permit the bar to enter the roll freely. In conjunction with the switch pipe, the control provides a fast accurate means of delivering steel to the coiling machine. The control functions as follows:

1. With no steel in the roll, the guide box is open and the water is shut off. When steel enters the guide box and the rolls, the eye on the exit side actuates a relay and closes the guide box and turns on the water. It might be mentioned here that if the water were left on, the leading edge of the bar would become chilled and fail to enter the roll pass causing a cobble.
2. When the end of the bar passes the eye, a timer is

Figure 2 — Repeater control is quite simple.



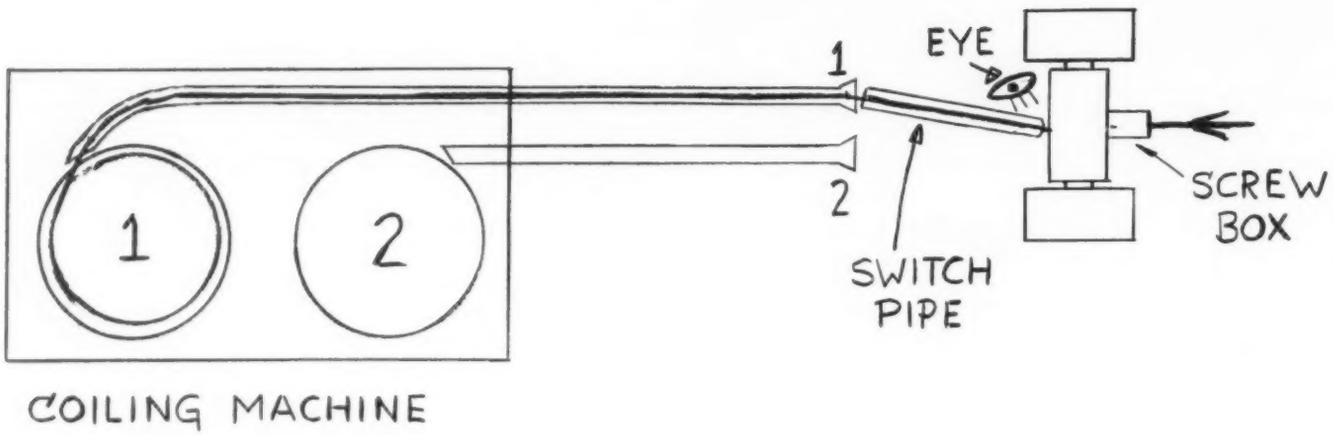


Figure 3 — The screw box opens and closes the guide to enable the bar to enter the roll freely.

actuated which when timed out will shift the switch pipe to the No. 2 position and then open the guide box to permit entry of the following bar.

HYDRAULIC SHEAR CONTROL

This control covers the following functions:

1. To automatically start, cut and stop the shear.
2. Time the entry of billets into the mill.
3. Count the billets.

The operation is as follows:

1. Eye No. 1 sights bar and actuates relay to shut off water on shear to keep billet from chilling.
2. Eye No. 2 sights bar and if also in sight of eye No. 1 actuates the hydraulic system and initiates shear cut.
3. Limit switch at end of stroke raises the shear stop, permitting the bar to go through to the rougher stop. At same time, shear is unloaded and returns to the open position.
4. Eye No. 3 sights bar and sets up interlock to stop repeat operation of shear. End of bar starts time cycle to close rougher stop. This times the entry of the billets into the rougher.

CONE ROLL SHIFTER

The cone roll shifter is a device to remove the bar from the entering rolls and onto the hot bed. Operation is as follows:

1. Eye sights bar entering chute to drag roll and starts timer motor.
2. When end of bar passes the eye, the timer chute is energized and the second timing cycle begins and shifts the cone rolls.
3. In approximately three seconds, the cone roll returns and at the same time the third timing cycle begins and picks up the rack, thus removing the bar from the rolls.
4. The end of the third time cycle, the rack returns and shortly thereafter the end of the first time cycle stops the clutch.

If the next bar does not immediately follow, the timer completes its cycle and stops the time motor. However, if the next bar follows in fast succession, the timer motor actually keeps running.

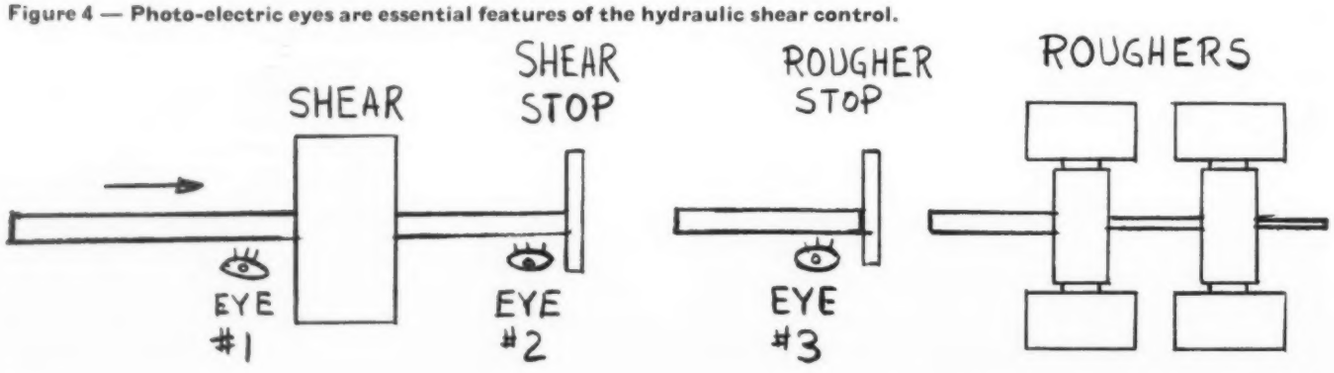
MAINTENANCE PROBLEMS

Controls are a vital factor in the operation of a plant because if one of them stops working, production also stops. An important thing to remember in connection with controls is that most instruction manuals furnished by manufacturers give definite procedures for maintenance, repair and adjustment and these should be followed carefully at all times.

The term control covers a wide variety of devices from the simple hand switch to the unit operated by magnet or motor, however, many of the components in the various devices are the same or similar so that a discussion of maintenance procedure on one will apply more or less to the majority of types.

One of the first things to consider is the atmospheric condition surrounding the control. Is there excessive dust present? Is any of it metallic or electrically conducting? Does the atmosphere carry gases? Is the humidity high and is the enclosure subject to water drip?

Figure 4 — Photo-electric eyes are essential features of the hydraulic shear control.



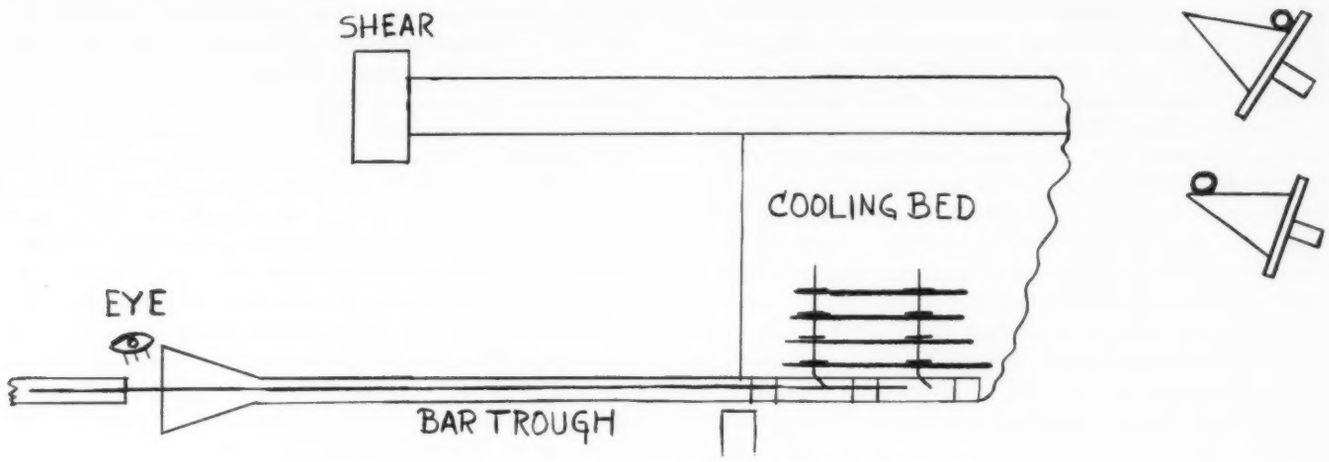


Figure 5 — Cone roll shifter removes bar from entering rolls.

If any of these conditions exist, the enclosures should be water-tight, dustproof or explosion-proof as conditions require. The gaskets of such enclosures should be inspected to insure tight fitting.

Cleaning and removal of dust, dirt and grime are essential. A dry cloth or dry compressed air is usually sufficient, but where there is an oil deposit, a solvent should be used, but in small amounts.

When cleaning, a check for corrosion or rust should be made. Check on all connections. Tighten all nuts and terminal screws. Check moving parts to see that there is no sticking or bending. Contacts, especially, need frequent inspection as some of them open and close hundreds or even thousands of times daily. The contact surfaces should be kept free from dust or oily deposit.

If the contact shows excessive pitting, it should be replaced, otherwise a fine file should be used but the original shape must be maintained.

Magnet coils should be inspected for mechanical injury and signs of overheating. Discolored or charred insulation may indicate a shorted coil. Check to see that magnet coils are immovably fixed to the frame—a shifting back and forth causes wear on the insulation and may lead to a failure.

Noisy or chattering magnets on an a-c control may mean a broken shading coil, a worn magnet face, accumulated dirt or grease, or magnet parts not properly alined. In short, a preventive maintenance program should be set up and maintained to insure maximum possible operation and, of course, maximum production.

Discussion

PRESENTED BY

NELS G. WIBERG, General Foreman Mechanical Maintenance and Lubrication Engineer, Republic Steel Corp., Chicago, Ill.

JOHN S. WYSOCKE, Assistant Plant Electrical Engineer, Wisconsin Steel Div., International Harvester Co., Chicago, Ill.

CARL WIDEN, Mechanical Foreman, Wisconsin Steel Div., International Harvester Co., Chicago, Ill.

Nels G. Wiberg: Since tubes are the weakest link in the control system, how often are they replaced? Is this done as a preventive maintenance routine?

John S. Wysocke: We have found that in all photoelectric control the weakest link would be the phototube itself. With long experience, when the tube is exposed to the radiation of the hot bar, 30 days was the maximum life we would expect. The amplifying tube would last about twice that or two months.

Carl Widen: When we have these time saving items, how do we know whether we have mechanical or electrical trouble when we get that cobble?

John S. Wysocke: When one is in the mill and has a cobble, it is always electrical trouble. However, the electrical department feels that there may be just as much trouble mechanically, be it guide or something like that, that could cause the cobble. However we have never been able to convince this mill organization that that is true.

"MODERNIZING OLD EQUIPMENT"

by J. DOBAY

General Foreman of Maintenance, Rolling Mills

The Youngstown Sheet and Tube Co.

East Chicago, Ind.

THE first objective in maintenance is to keep delays down to a minimum, or better yet to eliminate them completely. However, with old equipment and a twenty-turn operation, one can only do his best. Since two-thirds of the mill tables in the rolling mills are considered old equipment, (by old equipment is meant any roller line not equipped with anti-friction bearings) it is necessary to compile data such as delay time and maintenance manhours spent in keeping a particular piece of equipment running. From this data one can determine immediately where most mill delays occur, and where most of the maintenance manhours are spent. This latter part is very important because many times a mill delay will not show up due to the fact that every time there is a little downtime, we are checking and repairing this particular piece of equipment to keep it running. Therefore, the only data compiled would be the amount of maintenance manhours spent, which all know is undesirable.

Such an example was a problem on the bloom and slab shear approach table lines. While delay time which

occurred was at a minimum, dead table rollers hampered shearing operation, sometimes just 24 hours after a repair turn. Consequently, during the entire week, we were "brassing up" and realining table rollers whenever the mill was down for charging cold steel or cleaning scale. This became a very expensive maintenance headache; because, other than the constant maintenance manhours spent on the job during the week, one had to consider the cost of about twenty-five brasses, and also the welding and machining of two or three roll necks every week.

The reason for the abnormal wear on brasses and roll necks was scale being forced into the gear cases by the slab transfer chains and by the terrific amount of heat from the slabs when left lying over the roll neck bearing caps. Since it was almost impossible to keep the scale out of the gear cases, the forces were fighting a loosing battle, and that is when it was decided to modernize these tables with anti-friction bearings.

The method finally decided upon was very simple. The table roller would be assembled with two sealed roller bearing cartridges, with the gear end cartridge containing a two-row tapered roller bearing, and the free end cartridge containing a floating straight roller bearing. The line shafting also was assembled with sealed roller bearing cartridges containing split roller bearings, and a roller thrust bearing at the thrust end of the lineshaft.

The next problem was to burn out the old bearing seats in the table beam and girder, which was done with the aid of a template that gave the exact contour of the bearing cartridges. The table roller was placed into position and bolted down in the same manner as the bearing caps were. The table beam was also burned out to make room for the lineshaft cartridges and then it was installed in the same manner as the table roller. The results after two years operation are phenomenal. Downtime delays have been completely eliminated, material costs have been greatly reduced, and maintenance consists of a routine check-up once a week.

With the modernization program proving so successful on the shear approach tables, it was decided to try the same procedure with the scarfing approach table roller line. This too was another critical spot where there were not any delays, but numerous complaints on defective scarfing because of low rollers. Records showed that the first three rollers had journal brasses changed every week, and even with the frequency of the changes the brasses would not hold up until the next downturn. The reason for the bearing failure was obvious because with every scarfing operation the scarfing slag was blown into and under the bearing caps, mixing with the lubricant forming a very abrasive compound. The new installation was similar to the one used on the shear approach table, except that special burning equipment was used to scarf out the bearing retainer pockets because the table beam and girder were cast iron. It has been almost two years since this conversion was made, and the scarfing quality not only has been excellent; but the life of the scarfing unit head was also prolonged by eliminating the drag caused by the bloom due to low table rollers.

As stated earlier, the maintenance data gave a good indication of how delays and maintenance costs were running. In the previous two examples the material and maintenance costs were high. There was another case where delays, material and maintenance costs are all high. Such a situation existed on the main mill front and back table drives. These tables are not considered old equipment since all rollers, lineshafting, and drives are equipped with anti-friction bearings. The problem was that we were loosing pinion and intermediate shafts faster than we could buy them, and this was all due to bearing failure on the pinion shaft. The pinion shaft was assembled with two single-row, tapered roller bearings at each end of the shaft and when mounted in the bearing retainers; end plates with adjusting shims secured it for proper bearing alinement. The cause of our bearing failure was due to the fact that the millwrights were improperly using the adjusting shims for bearing alinement.

Under ideal conditions a single-row, tapered bearing can be properly alined; however, under field conditions a bearing cannot be properly alined with adjusting shims because of the time element. The result is that the bearing is either alined too tight or too loose and a consequent bearing failure would result. Whenever this failure resulted, improper tooth mesh would also result, causing tooth breakage in one or both mating gears. In order to get an idea of how serious this situation was, the material cost and delay time from two years back was averaged. The material cost of the gears and bearings was $10,500 for one year, and the delay time or downtime was twelve hours for the same period. These facts and figures show conclusively that a modernization of equipment was needed immediately in order to prevent further destruction of parts and to eliminate delays. A working plan which would eliminate the two single-row, tapered roller bearings on the pinion shaft was given to the maintenance engineer. The newly designed pinion shaft would have a two-row, tapered roller bearing on the free end and a straight roller bearing on the motor end. The different size bearings also necessitated a change in the bearing retainers, and within a week the shop had all parts ready for installation. The results of this modernization effort are now history, and all four drives have been installed with the newly designed pinion shafts. After one year of continuous service, records show that there were no mill delays on main mill table drives, there were no material costs, and maintenance has been cut to a routine inspection level.

The above mentioned ideas are also being used in different variations to modernize and improve other equipment, old and new, for a longer, trouble free life.

Discussion

PRESENTED BY

MICHAEL F. DENSHAR, Primary Mills Superintendent, Wisconsin Steel Div., International Harvester Co., Chicago, Ill.

J. DOBAY, General Foreman of Maintenance, Rolling Mills, The Youngstown Sheet and Tube Co., East Chicago, Ind.

CARL WIDEN, Mechanical Foreman, Wisconsin Steel Div., International Harvester Co., Chicago, Ill.

Michael F. Denshar: Did you replace any of the table rollers on a piecemeal basis?

J. Dobay: When we started modernizing the shear approach tables, the plant was operating 20 turns and had one 8-hr downturn a week. The job was planned on the basis of how many rollers could be handled at one time, because the table beams had to be flame cut, to fit the cartridges into place. It was possible to do two table rollers in 8 hr, and that was done every week. Two at a time were done.

Michael F. Denshar: Did you try to run without the table rollers?

J. Dobay: It was possible but not necessary since the job was always completed on time.

Carl Widen: Were these sections welded into the table beam or were they bolted in some manner?

J. Dobay: The cartridges were burned out and assembled on the roll. A template was made up so that when flame cutting the beams out, it was completed in one burning operation. The original cap bolts were used to hold down the cartridges.

Carl Widen: You mentioned the terrific scale problem before the conversion to anti-friction bearings. Has that scale problem been alleviated since, or do the anti-friction bearings get by?

J. Dobay: The first thing attempted to lengthen the life of the bearings was to try to keep the scale out of the gear boxes, but this was almost impossible. This resulted in using sealed cartridges. Ever since we do not worry about this because a double seal is put on each end of the cartridge. The inside seal is for the lubricant and the outside is for scale. The hardened gears can run in scale and lubricant at the same time, therefore the gear also has long life. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to that address.

1231 MELON, P.: "Rolls for Cold Rolling," *Rev. Univ. Mines*, 1945, Sept. 15, pp. 128–137. (Abstract J.I.S.I., 1947, Dec., p. 638.) Details are given of metals which can be cold-rolled, together with the uses, quality, and hardness of cold-rolled strip steels. The composition, hardness, fatigue, maintenance and defects of steel rolls for cold-rolling are described.

1272 KOROVCHINSKII, M. V.: "Stability of Position of Equilibrium of a Journal on an Oil Film," *USSR Akad. Nauk*, Symposium: "Friction and Wear in Machines," 1956, pp. 264–323. (Abstract preprinted from J.I.S.I.) A review of the theory of Stodola and its developments and a new formulation and complete mathematical development of a new conception of the problem are given. The conditions under which the elementary theory and this new approximate theory give the same values from the linear approximations suggested are defined.

1331 HOFSTEN, C. O. Von, and E. LINDSTRAND: "Some Experimental Investigations Regarding Wire-drawing," *Jernkontorets Ann.*, 1958, (3), 128–164. (Author's introduction.) For the research department of the Jernkontoret an experimental wire-drawing machine has been installed at the Sandvikens Jernverk. With this machine a number of drawing tests of various kinds have been carried out. The idea was to tackle a number of present-day problems which have not been cleared up by previous investigations. The main part of the investigation deals with the influence of different coatings on the drawing force and the temperature under different conditions. In addition, the optimum die angle and the effects of having a rotating die were studied.

1365 A KOPINECK, H. J., et al, "Ultrasonic Testing of Products in the Iron and Steel Industry," *Stahl u. Eisen*, 1959, May 28, pp. 786–797. (Extended abstract—2000 words.)

1386 SCHEPERS, A., and F. R. LIGHT: "Measuring the Wear of Blast-Furnace Linings by Means of Radio-active Isotopes," *Stahl u. Eisen*, 1959, May 14, pp. 669–674. (Abstract preprinted from J.I.S.I.) Type of blast-furnace brickwork studied and methods of measuring the wear of the brickwork with 60 Co are described. It was found that the originally 1000-mm thick brickwork is worn down to about 150-mm immediately above the tuyeres in a few months, in the other parts of the furnace this amount of wear was found after about 12 months.

1395 FUSSL, E.: "Oxygen in Open-hearth Furnaces. Data From Reports and Practice. I—Modern Processes," *Radex Rund*, 1959, May, pp. 533–545. (Author's summary.) Kinds of oxygen application in the open-hearth furnace; oxygen nozzle; oxygen lance; effects on output, heat consumption and refractories influence on investment costs of steel plants.

1446 RYTEL, K.: "Possibilities of Saving Steel in the Use of Sections," *Neue Hutte*, 1959, (6), pp. 343–351. (Author's summary.) This paper offers a possibility of determining the saving of steel in the manufacture of sections. It gives information about difficulties and problems in the widely used sections. A quantitative analysis of the possibilities of steel saving and the change in manufacturing costs to be expected therefrom is given. Welding of H sections presents the greatest possibilities but involves the highest costs. There is no reduction of rolling mill capacity. With other measures, reduction of web thickness or total wall thickness, the cost increase is smaller, but rolling mill capacity is reduced.

Simplified Records Aid Progressive Maintenance

by D. M. PETTY, JR., Superintendent, Mechanical and Electrical Dept., Pacific Coast Div., Bethlehem Steel Co., South San Francisco, Calif.

. . . . a record system furnishes the information which is needed to develop the answer to the "where, why and what" questions which are needed to carry out a progressive maintenance program . . . .

FOR a great many years, responsible personnel in steel mill maintenance have strived to reach the optimum between extravagant expenditures for repair-free, delay-proof equipment and the falsely economical "haywire" type operation. This goal or quest has been attained with varying degrees of success in practically every steel mill in the world. The complexity and sheer volume of operating components in the modern industrial plant require some formalization of maintenance records as a tool to progressive maintenance systems. The purpose of this paper will be to present one plant's answer to this problem, in which a simplified approach to historical records is felt to offer the optimum operating control with a minimum of complexity and expense.

Today's potential trouble makers are astounding just by the overwhelming numbers involved. A typical small steel plant has several hundred motors, approximately 1000 conveyor rolls, 500 crane wheels, 6000 assorted bearings, 4000 gears, sprockets and pinions, plus various assortments of shafting, chains, frames, brakes, clutches, rails, burners, etc. All of these wear out, burn out, break down, freeze up, twist off or just disappear. The repairing, replacing, reinstalling and the retiring of these parts is in itself a multimillion dollar business.

Of this volume of components which make up the steel plant's mechanical and electrical complex, the sizable individual units responsible for large dollar expenditures as a result of material failure or excessive operating delays are quite easy to identify as being trouble sources simply because of their size and individual production contribution to the plant. There are, however, a multitude of minor delays and repairs of individual components that by themselves have no great dollar value, nor do they individually cause any great loss of production; nevertheless, small delays do total up to a surprisingly high dollar figure. It is this loss that also must be brought under control.

In the initiating of any intelligent action against an undesirable force or circumstance, these undesirable elements must first be located and identified. In this case, they are those units that are susceptible to recurrent, minor repairs or delays. The recording of the actions taken against these units must also be provided for in the plan to be followed so as to satisfy both the historical and statistical requirements. The trend is towards more and more detailed cost accounting in all phases of production operations; therefore, it is possible to find many systems of maintenance recording in use and on the market. Examination of the systems in use in the plant under discussion quickly divided them into two major categories.

These two categories are:

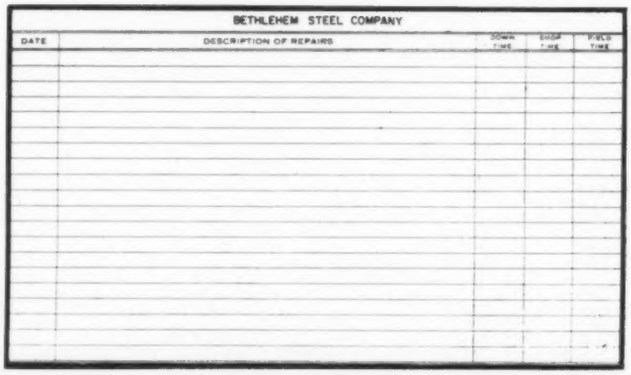
1. The check-list type, that is used for insuring the performance of certain fixed routine maintenance operations.
2. The diary type, that gives a chronological history of repairs accomplished on any one day.

There are, of course, a host of other variations and combinations of these that have been used to meet a particular localized requirement. In the case under discussion, the requirements to be met were:

1. The system must be compact.
2. The records must show the following:
   (a) Material failure or foreshortened life.
   (b) Labor time.
   (c) Production delays.
   (d) Quick indication of trouble-prone units.
3. The information must readily be placed into the record.
4. The information given the posting clerk must be easily understood.
5. The information must be current.
6. The information must be easy for the mechanics to orient with their work.

As will be shown later, the system can go considerably beyond these requirements and into real inventory control based upon accurately known demand rates. Design standards can be obtained from the detailed knowledge of a component's life in a given environment. Inadequacies in the present design can be easily spotted and analyzed for actual operating cost, and the course of action to be taken can therefore be justified with considerable accuracy on any given project. It is also possible to effectively schedule maintenance group daily operations from this system.

Figure 1 — This card is the key item in a records program.



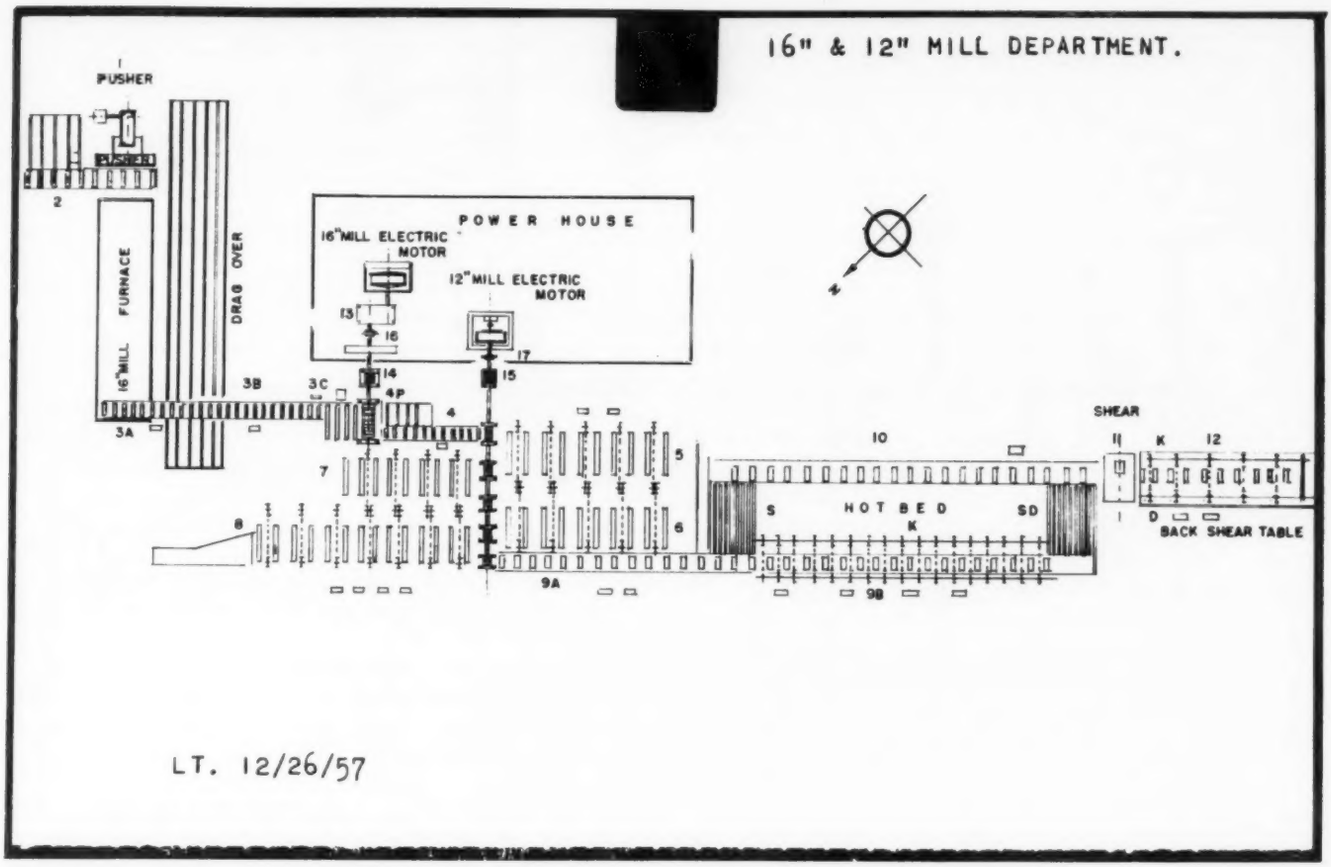


Figure 2 — Areas were broken down and assigned a number.

The logical starting place in the building of a records system is the information storage cell which in this case is a file card. The card must show the following information:

Date.
Brief description of the action taken
Production delay.
Shop time.
Field time.

Figure 1 shows the card described.

The card must now be identified with the particular single unit involved in such a manner that both the repairman and the clerk understand what unit has been worked on. This problem was resolved by first making miniature layouts of the major producing units. Figure 2 shows this drawing with the natural divisions numbered. For example, the furnace pusher is No. 1, the back shear table is No. 12, and the 16-in. mill

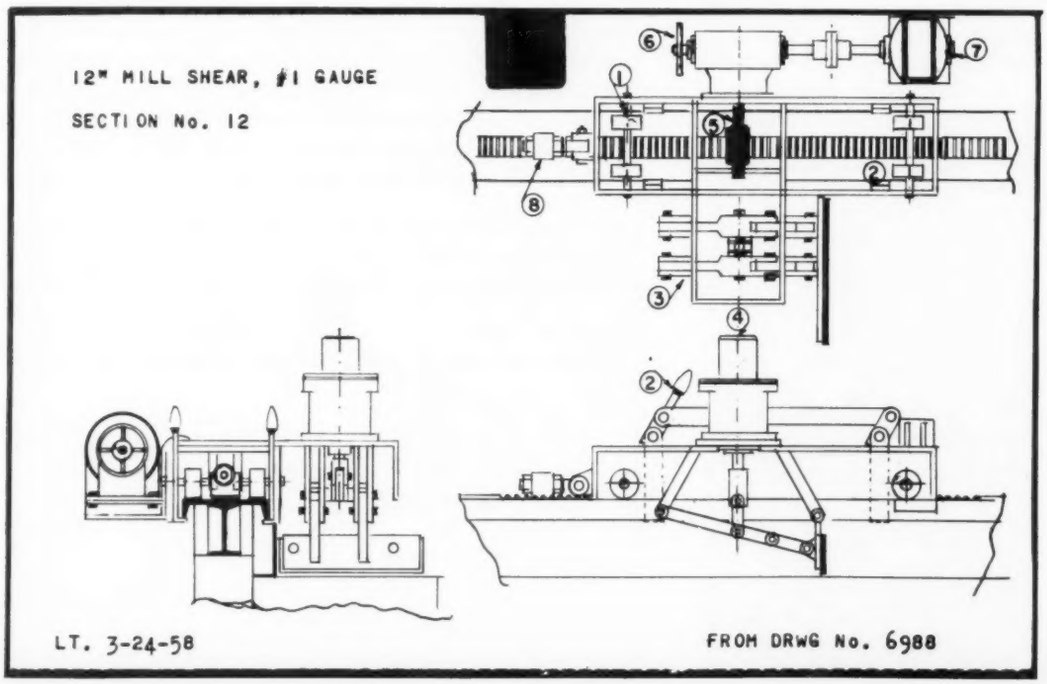


Figure 3 — To further help identification a detailed layout is given to each section.

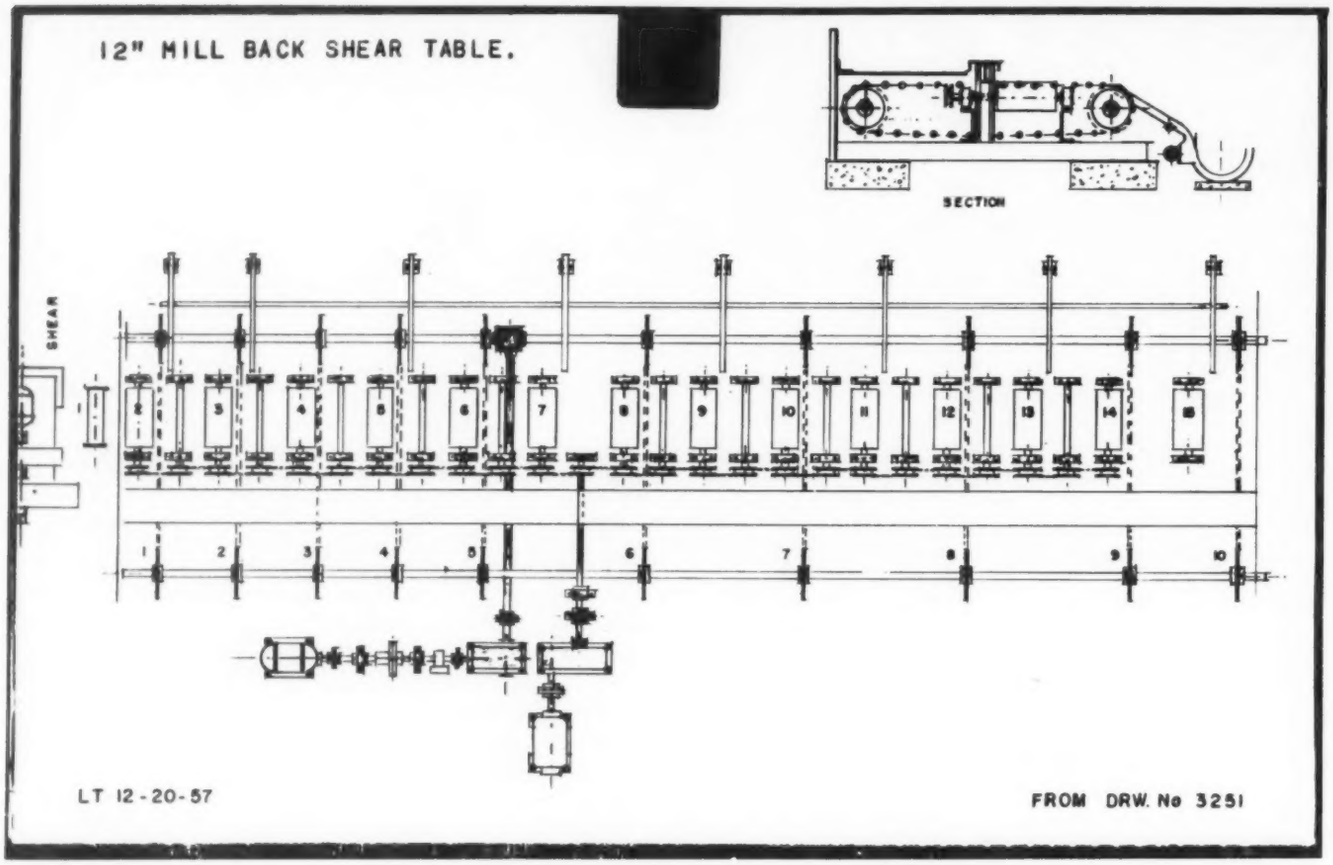


Figure 4 — Additional numbering is shown on this layout.

main drive reduction unit is No. 13. For the next step in the identification procedure, layout drawings were then made of each section. Figure 3 is a detailed layout of the shear gage of section No. 12. Figure 4 shows a detailed layout of the back shear table conveyor with the rolls and kickoff sprockets numbered. Subassembly and component assembly replacement has been practiced in this plant for a number of years, so the next part of the identification job was already accomplished. This final phase was to identify the component and subassembly in terms of complete replacement units.

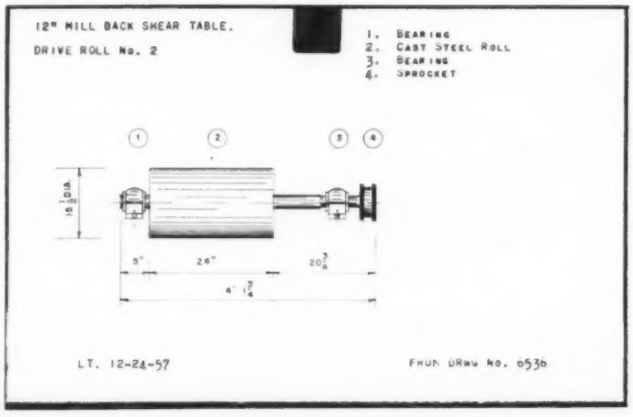
To illustrate a typical component, Figure 5 shows the identification drawing for the back shear table conveyor rolls, No. 2 to No. 14. When there is work to be performed on these rolls, they are replaced completely, as shown in the drawing, brought to the shop, inspected, repaired and then placed in spare parts inventory. This practice has been applied, wherever possible, not only to conveyors but to all types of mill equipment. Identification is now complete for the subassembly, and this information is noted on the card. Figure 6 shows the card with four spaces in the lower left-hand corner. The primary identification is made in the bottom two spaces, because these are exposed when the card is placed in the file. The two upper spaces are used for secondary identification when needed. Both the primary and secondary identification is made by a simple statement such as, "conveyor roll," "runout table," "18-in. shear gage."

To indicate those components that are giving the most trouble without having to go through the entire file is one of the requirements that must be fulfilled. Since the number of entries will be proportional to the amount of trouble encountered with that particular unit, all that must be done is to show the number of entries on each card. The cards are purchased precut to accommodate a plastic sliding indicator used in conjunction with this system. Figure 7 shows a blank card with the plastic slide in place. It will be noted that there are twenty spaces and twenty lines on the card. Normally each entry is limited to a simple one-line statement. In the extreme lower right-hand corner there is a space provided for a carry-over total from a previously filled card.

The information storage cell is now completed. It furnishes, in a quick and easily recognizable manner, the data necessary for maintenance control.

The only remaining phase to consider is the link between the posting clerk and the mechanic performing

Figure 5 — Breakdown of typical component which here is a table conveyor roll.



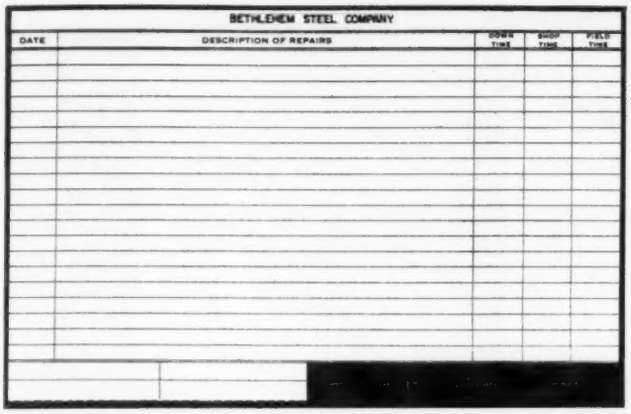


Figure 6 — Primary identification is made in bottom space of card.

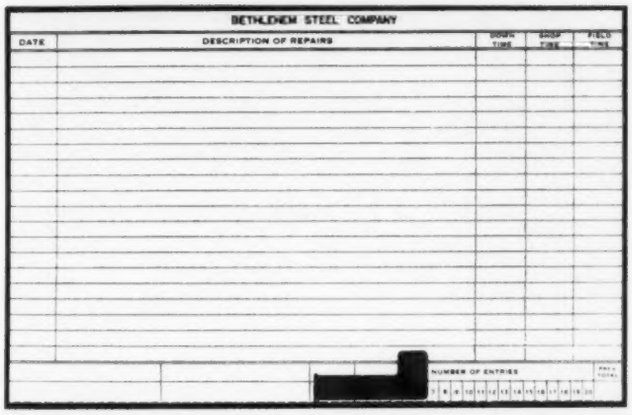


Figure 7 — Plastic slide on card calls attention to areas where there is much trouble.

the repair. It was decided that a simple form would be used to show only the information needed by the posting clerk and no more. Figure 8 shows the blank form that is to be filled in by the mechanic after a repair is accomplished.

Quick and positive identification are made by the mechanic by referring to an index book containing duplicates of the file drawings shown earlier. Figure 9 shows the index books with a supply of blank forms that are placed in the machine shop.

The process of identification can best be illustrated by going through the steps followed by the mechanic after making a repair to the No. 4 roll on the back shear table. This roll is identified by referring to the index book in the shop. Figure 10 shows the drawing pertaining to this job as it appears in the index book. This is the mill layout identifying the back shear table as Section 12 of the 16—12 in. mill. Figure 11 is the drawing that numbers and identifies the components of section 12. Figure 12 is a drawing of a roll assembly from Section 12, identifying the roll as being one from No. 2 to No. 14. A blank form is then completed as shown in Figure 13. This form is passed to the posting clerk who goes to the file and pulls the drawer marked *12-in. mill Section 11 and 12.* He will go to the subsection marked *back-shear table* and to the card for roll No. 4. The entry is made, and the indicator tab is moved up one more space. The identification drawing and cards used by the clerk to identify the proper component are identical to those in the index book. He will not have to refer to the drawings except for confirmation of doubtful entries, since the bottom line of each file card carries sufficient information to correlate it with the mechanic's identification. This concludes the posting operation.

The information is regularly entered on the cards, and the indicator gives a quick summary of where work is being done. These cards are checked daily by the foremen to keep an accurate check on their trouble spots. Often what has been reported as "a lot of trouble on the 12 in. mill cooling bed" turns out to be several isolated instances that have recurred at various times to specific components in the section. A hopeless generalization of several people is refined, by applying this record system, into an exact description of a series of failures. For example, No. 17, No. 18, and No. 19 rolls in one conveyor, No. 3 roll in another conveyor, and the second intermediate bearing in one gear case were all pinpointed as specific trouble spots. Previously, a general description of such failures obscured exactly where and what the trouble was, and it was written off as routine wear and tear.

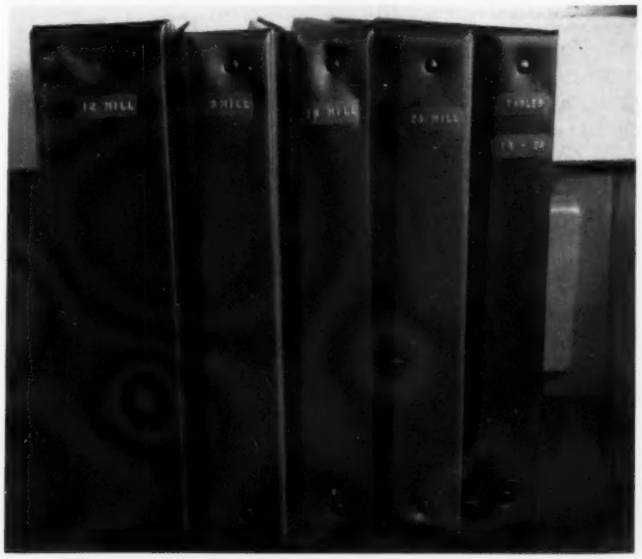
In the several instances noted, analysis of the repetitious failures justified an equipment redesign. To illustrate with a specific case, look again at Figure 2. This is a picture of the section including the runout conveyor, Section 10, of the 12-in. mill cooling bed.

Figure 8 — This card is used by the mechanic performing the repair to inform posting clerk.

DATE _____ JOB LOCATION _____ REPAIRMAN _____

DESCRIPTION OF REPAIRS & OR REASON FOR CHANGE	DOWN TIME	FIELD TIME

Figure 9 — Index books contain duplicates of file drawings.



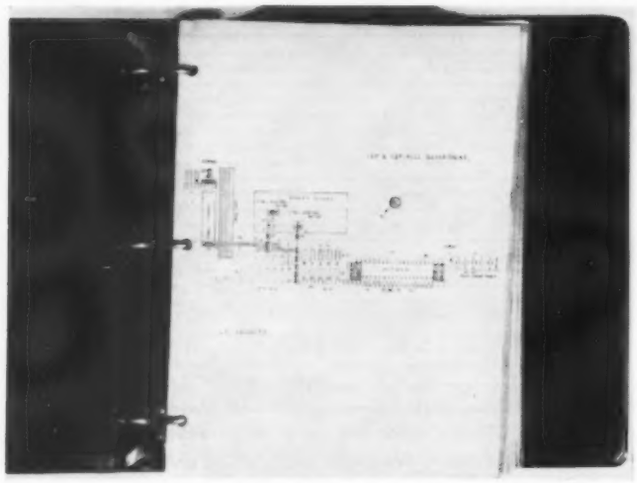


Figure 10 — Index book has drawing which gives mechanic reference.

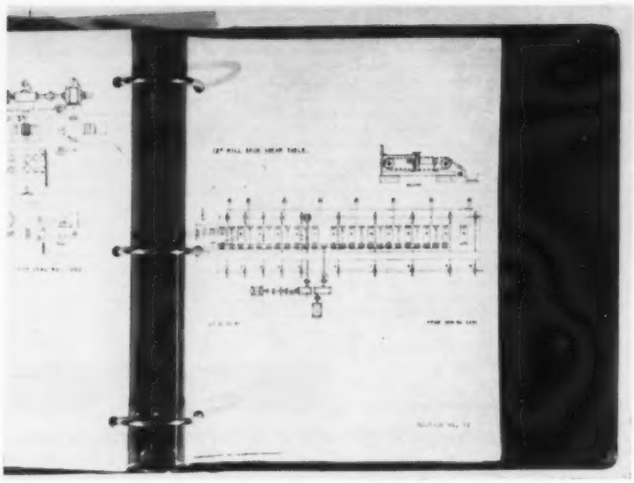


Figure 11 — Components are identified from this page in the index.

After the record system had been in use for about 18 months, it was noticed that the indicator for rolls No. 7 and No. 8 were advancing ahead of all the others in that conveyor. A quick glance at the drawing at the head of the section made it apparent that rolls No. 7 and No. 8 were carrying the power load for the entire conveyor. It was decided to move the drive unit to a location that would divide the load more evenly. The subsequent performance of this section indicates that this was a correct solution.

The introduction of a new system to any group requires their understanding of the system, if they are to operate it effectively. This was no exception. From the start, the clerical staff and the mechanical foremen were brought into all phases of the planning. The system that resulted has both the best ideas of these people and their good will and support. The craftsmen were the easiest group to "sell." Within weeks after the first section was put into operation, the mechanics and machinists started coming into the office to see that their work was promptly and accurately entered on the cards. Also the foremen began using the files as a basis for planning week-end maintenance in some areas, and they expect to expand this use.

One reason for this quick and enthusiastic acceptance of the system was the clarity and simplicity of the drawings. The personnel involved could understand the drawings and readily see how their activities fit into the record system. Pressure from within the department developed to get the unfinished sections of the system completed as rapidly as possible. With enthusiastic backing such as this, there has been no problem in maintaining the prompt flow of accurate information.

The system requires about five manhours per week of clerical time, and only minutes per day of mechanics' time to assemble and enter all the current information.

At present, only the sections of the plant under the mechanical department foremen are covered by this plan. Approximately one man-year of clerical and draftsman time was required to complete the 2300 cards, make the mechanics' books, and formulate the daily forms required to operate the system. The results from the first year's operation have more than justified this investment. It is intended to establish similar systems in other units of the mechanical and electrical department in the near future.

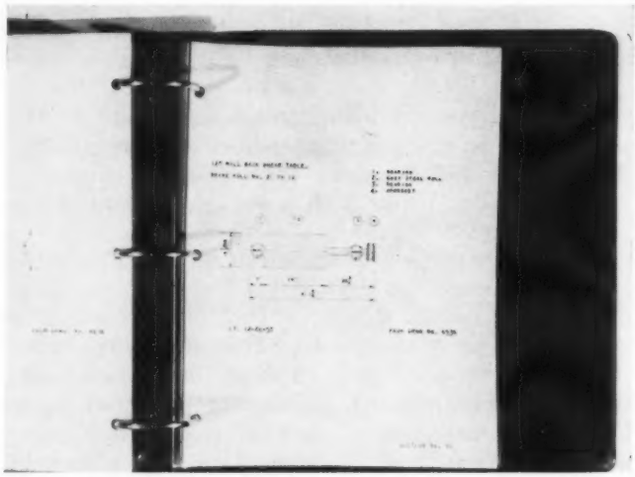
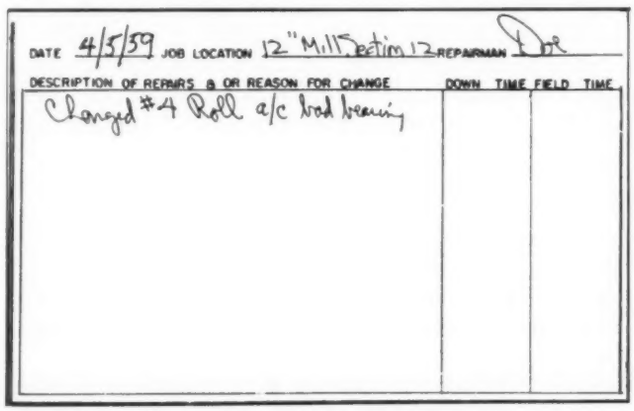


Figure 12 — Additional information is given by this page.


DATE 4/5/59 JOB LOCATION 12" Mill Section 12 REPAIRMAN [illegible]

DESCRIPTION OF REPAIRS & OR REASON FOR CHANGE	DOWN TIME	FIELD TIME
Changed #4 Roll a/c bad bearing		

Figure 13 — Mechanic completes form as shown.

Experience to date has shown a good possibility of getting effectively into life rating of components in specific environments and into the associated fields of economic inventory control of spare parts and redesigning of unsatisfactory components. The ultimate result of all this will be better equipment availability, longer component life, fewer spares, and smaller repair crews; in short, lower maintenance costs.

This paper has shown what one plant is doing to accomplish this end by the application of a records system which answers the "where, why, and what" question which is necessary to accomplish a progressive maintenance program. ▲

The reconditioning program carried out at Geneva, although costly, has been a big factor in contributing to the production records set at this plant.

Figure 1 — To be self-sufficient a rather complete central maintenance shop has been found valuable.

Electrical Maintenance Program at the Geneva Plant

by H. A. HUISH, Assistant Division Superintendent, Maintenance and Utilities,
Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

THE Geneva plant of Columbia-Geneva Steel Div. of United States Steel Corp. is a fully integrated steel producing facility. The location of the plant, near Provo, Utah, is remote from a concentrated manufacturing area and consequently lacks nearby specialized service facilities. The Geneva plant must, therefore, be self-sufficient in the maintenance of its equipment. Since the original installation in 1942 and 1943, the complement of machine tools and equipment in the central maintenance shop, Figure 1, has continuously been improved, with maximum flexibility in mind.

The purpose of this paper is to describe one phase of the complex planning and operations which are necessary to be self-sufficient in the maintenance of steel mill equipment. The phase to be described—the planned reconditioning and spares program for major electrical drive equipment—for the most part directly concerns the slabbing and the plate and hot-strip mills. In the past few years this phase of the maintenance program has received considerable attention because the original large electric drives had reached an operating age of 15 years and insulation failures could be expected to occur with increasing frequency.

The first major insulation failure occurred in November of 1954 on a 7000-hp, wound-rotor motor. This motor drives the generators for the plate and hot-strip mill reversing rougher drive. The insulation failure occurred in the rotor as a result of a mechanical failure of the slip rings. The plate and hot-strip mill would have been down during the rewind of the rotor if it had not been possible to provide temporary emergency d-c power for the reversing rougher motor. Emergency power was provided by connecting a 3500-kw finishing stand generator to the rougher drive and by controlling this generator from the rougher generator controls. This was accomplished in 10 hours. The top speed of the reversing rougher drive motor and the current limit setting of the controls had to be reduced. Thus, produc-

TABLE I
Typical Example of the Reconditioning Program

Unit	Data	Spares	Scheduled for Reconditioning
(1) Scalebreaker No. 1 1250-hp motor	1250-hp, frame M30 240-rpm, 6600-v, a-c	...	1957
(2) Broadside stand 4500-hp motor	4500 hp, frame M48, 150-rpm, 6600-v, a-c	...	1958
(3) Reversing roughing mill	3500-hp, frame MCF20	(1) Armature	1956 armature and field
(A) 3500-hp motor	25/60-rpm, 750-v, d-c		
(B) 3500-hp motor	25/60-rpm, 750-v, d-c		1959 field only
(4) Flywheel motor-generator set			
(A) 7000-hp motor	7000-hp, frame M14 514-rpm, 6600-v, a-c	(1) Motor (same as slab mill)	Not scheduled during duration of this program
(B) 1750-kw generator	1750-kw, frame MCF12 514-rpm, 700-v, d-c	(1) Generator (same as slab mill)	1957
(C) 1750-kw generator	514 rpm 700-v, d-c	...	1957
(D) 1750-kw generator	514 rpm 700-v, d-c	...	1957
(E) 1750-kw generator	514 rpm 700-v, d-c	...	1957
(5) Roughing mill auxiliary motor-generator set No. 1			
(A) 1250-hp motor	1250-hp, frame TSHL8 900-rpm, 6600-v, a-c	...	1955
(B) 500-kw generator	500-kw, frame MCF6 900-rpm, 600-v, d-c	(1) Armature	1955
(C) 150-kw generator	150-kw, frame BB 211.6 900-rpm, 250-v, d-c	(1) Armature	1958
(D) 100-kw generator	100-kw, frame 185.5 900-rpm, 250-v, d-c	(1) Armature	1959
(E) 40-kw generator	40-kw, frame 153 900-rpm, 250-v, d-c	...	1957
(6) Roughing mill exciter set No. 1			
(A) 60-kw generator	60-kw, frame CD 1441 1200-rpm, 200/400-v, d-c	(1) Generator	1955
(B) 30-kw generator	30-kw, frame CD 1239 1200-rpm, 50-v, d-c	(1) Generator	1956
(C) 125-kw generator	125-kw, frame CD 1556 1200-rpm, 200/450-v, d-c	(1) Generator	1955
(D) 25-kw generator	25-kw, frame CD 1126 1200-rpm, 250-v, d-c	(1) Generator	1956

tion continued during the two-week rewind period, but with a decrease in average production rates and with the postponement of difficult orders which would heavily load the mill. Even though this temporary emergency job was accomplished without undue complications and production loss, it was adjudged far better to provide a scheduled outage than be forced to delay a customer's order. In 1949, six years prior to this failure, planning was begun for such eventualities; however, this failure emphasized the necessity for an equipment reconditioning program.

Table I shows a typical example of the reconditioning program. This program covered all the major drives and associated auxiliaries in both the slabbing mill and the plate and hot-strip mill. The studies encompassed all equipment essential to continuous operations, and even included fan motors. The decision to acquire spare armatures, spare motors, and spare fields for all equipment was based on outage costs and production losses. Table II shows a portion of the studies.

In order to insure production and maintain continuity of a reconditioning program, the acquisition of spares was emphasized. With the acquisition of spares, it became possible to recondition rather than rewind

TABLE II
A Portion of the Mill Downtime Comparison With and Without Spare Units

Mill Unit	Spare Units Originally Proposed	Mill Downtime Required To Rewind Units	Spare Units Proposed Under Revised Plan	Mill Downtime to Install Complete Spare Unit
Slab mill—flywheel motor-generator set (4) 2250-kw generators	(1) Dummy shaft	14 days for each generator—56 days total	(1) 2250-kw generator complete	1 day for each generator—4 days total
Plate and strip mill—flywheel motor-generator set (4) 1750-kw generators	None	14 days for each generator—56 days total	...	1 day for each generator—4 days total
Slab mill—flywheel motor-generator set (1) 7000-hp motor	None	21 days (complete)	(1) 7000-hp motor complete	2 days
Plate and strip mill—flywheel motor-generator set (1) 7000-hp motor	None	21 Days	(1) 7000-hp motor complete	2 days
Plate and strip mill reversing rougher (2) 3500-hp motors	(1) Dummy shaft	21 Days each armature	(1) Armature complete (1) half-field	3 Days each (with half-field)

TABLE III
Showing Spares for Main Drive Rotating Equipment Slab Mill and Plate and Hot-Strip Mill

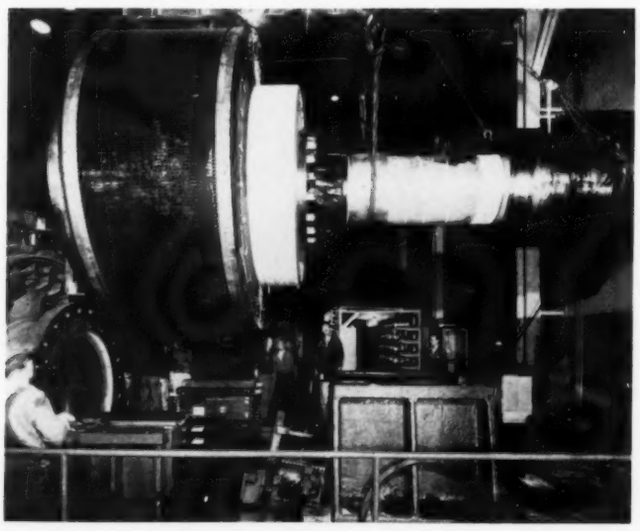
Unit	Rating	No.	Spare equipment
Plate Mill			
Finishing stands 1 through 5	5000-hp	5	Armature
Finishing stand 6	5000-hp	1	None (coils only)
Finishing stand motor-generator set	9800-hp synchronous, motor, 3500-kw generator	3 6	Spare motor (11,200 hp) Armature
7000-hp motor-generator set	7000-hp wound rotor motor	1	Spare motor*
	1750-kw generator	4	Spare generator*
Reversing rougher	7000-hp double-armature	1	Armature and ½ field with yoke
Slab Mill			
7000-hp, motor-generator set	7000-hp,wound rotor motor	1	Spare motor*
	2250-kw generator	4	Spare generator*
Twin drive	2 × 5000 hp	2	Armature

* Fits plate mill.

major drive equipment, thereby extending life from the 15 years experienced to an anticipated 20 plus years.

A list of the spare equipment for the large drive systems is shown in Table III. Finishing stands 1 to 5 were listed together because they are duplicate machines. No spare was furnished for stand No. 6 motor since such a spare would have been single purpose, and since a wide range of products could be rolled without this motor. The spare 9800-hp synchronous motor (actually 11,200-hp with modern design) serves three units. The spare motor for the two 7,000-hp motor-generator was constructed for 13,200 or 6,600-volt service and has two removable shafts, one for each position. The spare generator for the two 7,000-hp motor-generator sets was constructed to fit eight different positions with four different shaft sizes. This generator was designed for two voltage ratings. Field resistor combinations were provided to obtain the necessary transient characteristics. No spare was provided for the broadside mill motor, since if it should fail, the reversing rougher could do the extra work with a slight decrease in the producing rate.

Figure 2 — This 3500-hp, reversing rougher armature is one-half of a double armature unit.



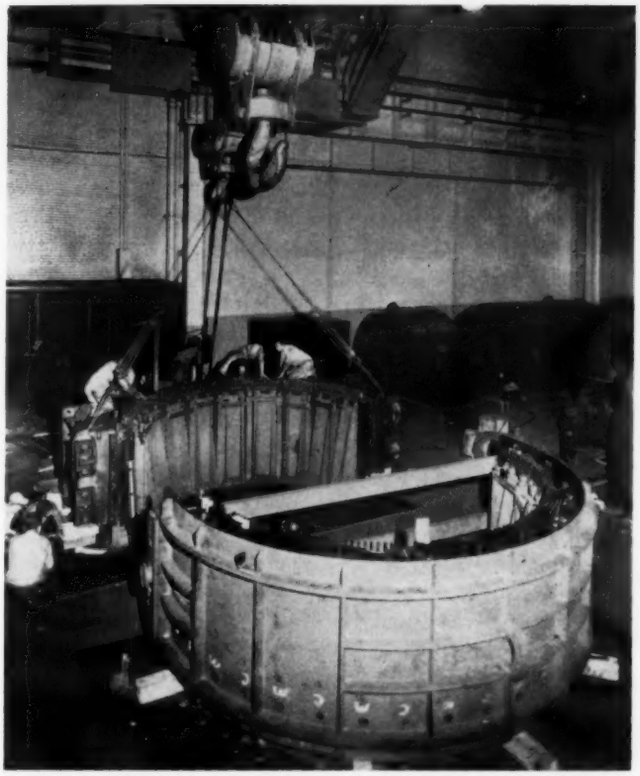
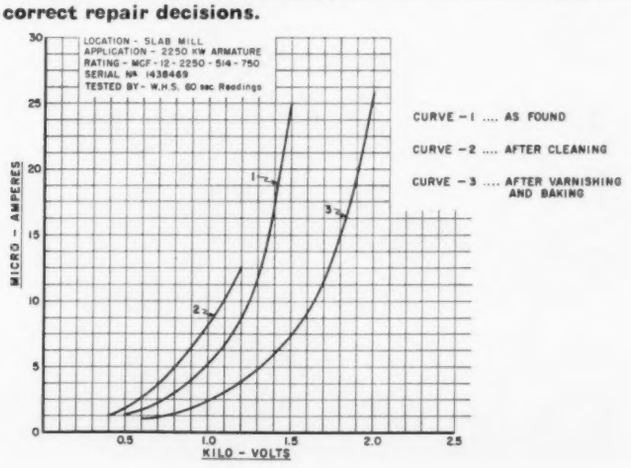


Figure 3 — Maintenance planning is based on a spare half-field assembly.

The armature for the reversing rougher drive motor, shown in Figure 2, is one-half of a double armature motor. It is impressive in its size, weighing about 90 tons, and is a single purpose spare. The importance of the reversing rougher drive motor fully justified the expense of a spare armature and a spare half-field assembly. Figure 3 shows the arrangement used for changing one-half set of field coils which provides a completely preconnected half-field assembly.

The reconditioning program for the slab and the plate and hot-strip mill electrical drives required an extremely large initial expenditure for the acquisition of spares; the continuing program, however, will be less expensive. During the period from 1954 to the present, all of the original equipment has either been reconditioned or rewound.

Figure 4 — The d-c high voltage insulation test helps make correct repair decisions.



The acquisition of spares resulted in a change in the maintenance philosophy. It became possible to replace a unit and restore production in a fraction of the time previously required for repair. Commencing in 1957, three finishing stand motors suffered failures. Damage to the machines varied from light to moderately severe burning of the equalizer windings. It would have been possible to repair the damage, but because the failures indicated a weak point and a spare was available, the armatures were completely rewound, permitting the installation of design improvements.

A problem encountered with the reconditioning program was that of determining whether a machine should be rewound or reconditioned and its suitability for service after the work had been completed. A thorough visual inspection and the knowledge gained through experience of the most critical points of each machine are the most reliable determinants of a machine's general condition. D-C high potential insulation testing of d-c machines was adopted, however, to aid in making a good decision. For newly rewound machines the limit held on voltage is determined by the commutator insulation, and for reconditioned machines the limit held on voltage is determined by a desired safe margin during the test. Figure 4 illustrates a graph of leakage currents versus d-c kilovolts for a 2250-kw, 750-volt, d-c generator armature during various stages of reconditioning. Curve 1 is the plot that was taken when the armature was removed from service. The windings were covered with carbon and dirt at that time. Curve 2 is the plot after the second cleaning with solvent. Curve 3 shows the condition of the armature after it had been varnished and baked thoroughly dry. The time lapse between curve 1 and curve 3 is about five weeks. Figure 4 demonstrates that replacing a machine in service with improper cleaning and varnishing and without thoroughly drying can greatly increase the possibility of failure.

Figure 5 — Belt-drive is used to turn armature during banding operation.

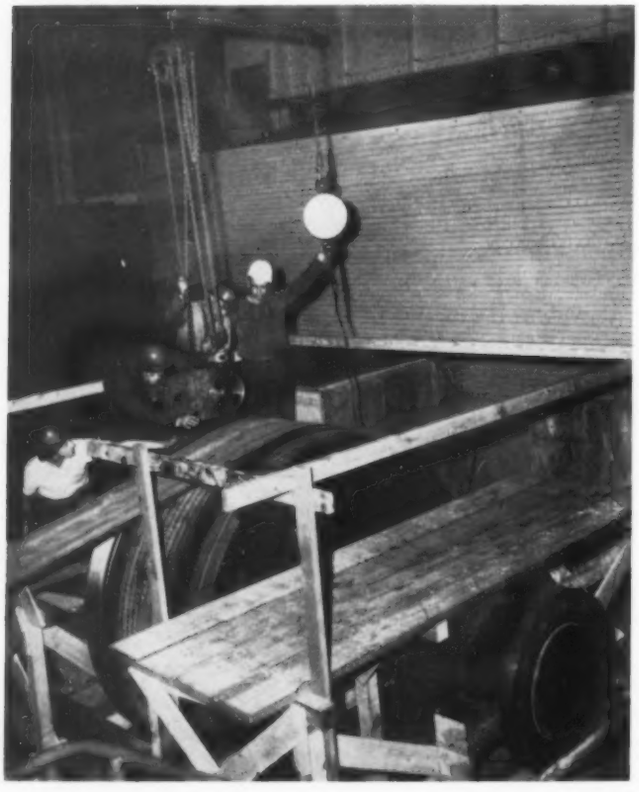


Figure 6 — Armature is being varnished.

The use of the d-c high potential tester has been very effective in determining if a rewound or reconditioned d-c machine is satisfactory. It has also been very effective for determining weak spots in the machines. In each case where the machine has failed during the high potential test, further investigation has shown that the weak spot existed and would probably result in premature failure.

Another tester, which has been of great value to the program, is a pulse generator and detector used for setting brush position. On the large machines the commutating field strength has been accurately set by the factory so that the machine's brush position is very nearly correct when set on the neutral point as determined by the tester. The simplicity of the testing procedure and the speed with which the neutral point may be determined has been of great value in the installation of the units. Careful brush alinement and spacing, together with the use of the tester, have resulted in a minimum of commutation troubles.

The actual rewinding and reconditioning operation has been, for the most part, performed in the motor room associated with the equipment. On several occasions, however, when the work load has exceeded the available manpower at the Geneva plant, units have been shipped by truck to a service shop.

The field rewinding including banding, varnishing and baking, has become a routine operation. A typical nonemergency rewind, of a 5000-hp armature requires about 30 days and about 2000 manhours including moving and handling.

Figure 5 shows a banding operation in progress and the belt-drive employed to turn the armature can be

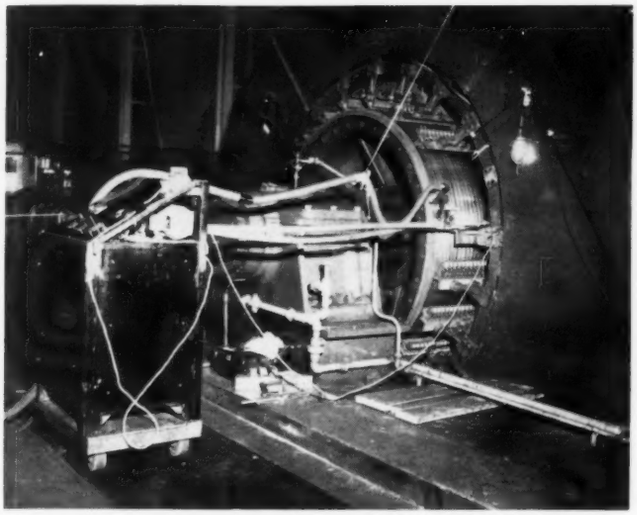


Figure 7 — An automatically controlled lathe is used to recondition commutator.

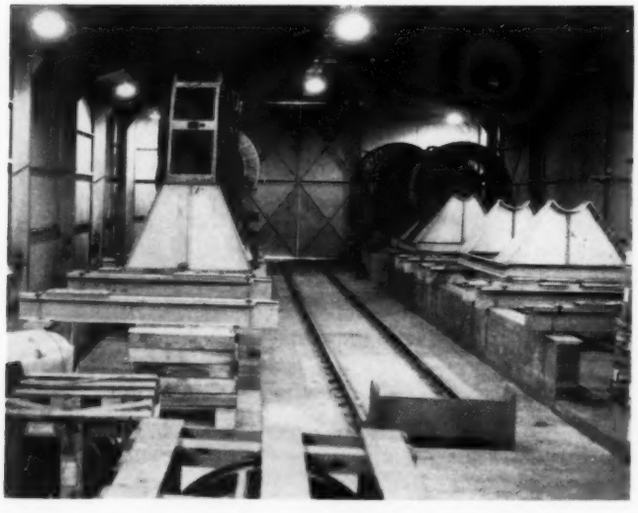
seen passing over the top. The armature is resting on a permanent wood crib constructed for the armature; the scaffolding, of course, is a temporary structure. Figure 6 shows an armature being varnished. The banks of infrared heat lamps are used to preheat the armature to about 250 F before the varnish is applied. The varnish is applied by rotating the armature in a varnish bath.

Reconditioning of a typical armature winding requires a thorough inspection and d-c high potential test when the unit is removed from service. The windings are cleaned by immersion in an air-agitated solvent solution. Solvent is also sprayed from inside the armature spider out through the air ducts to insure complete cleaning. The unit is dried completely with the use of banks of infrared heat lamps.

Tests are then made to determine the effectiveness of the cleaning operation. When cleaning is adjudged satisfactory, the armature windings are preheated and dipped in varnish tanks as illustrated in Figure 6.

An important facet of any maintenance program for d-c machinery is commutator conditioning. To facilitate turning commutators, an automatic magnetic-amplifier controlled lathe was designed and constructed. Figure 7 shows this machine in operation. This lathe allows one man to turn a commutator to a mirror finish in complete safety even on an energized machine.

Figure 8 — A separate building is used for storing electrical spares.



The acquisition of spares, both machines and winding materials, created a storage problem. Electrical insulation deteriorates with age, and for some insulations improper storage will result in rapid deterioration. To overcome this problem, a separate building was constructed for the electrical spares. The air in the building is conditioned to maintain humidity at an optimum level. Figure 8 shows a view inside of the electrical spare parts storage building. It should be noted that railroad transfer cars have been provided to move the equipment from the storage building to the motor rooms. During planned outages, a particular spare can be moved on a scheduled basis, and during an emergency, the time required to remove the unit which has failed can be utilized for the transfer operation.

At the beginning of the rewind and reconditioning program there was some concern regarding the methods to be used and how much outage time would be required. Procedures are now well developed and job descriptions are prepared for each of the major units including required tools, materials and manpower. Unanticipated failures, such as those experienced on the finishing stand armatures, are now handled in a nearly routine manner.

The reconditioning program, as has been pointed out, was very costly to inaugurate, but it was one that was viewed as a necessity. We have not attempted to evaluate the savings in reduced downtime and lost production which can be attributed to the available spare units. Neither can we accurately tell which units would have failed if they had not been reconditioned. However, the past portions of the program have been accomplished during periods of high production demands and have surely contributed to the production records set at the Geneva plant during those periods.

Discussion

PRESENTED BY

E. H. MYERS, Manager,
D-C Motor & Generator Engineering,
Large Rotating Apparatus Dept.,
Westinghouse Electric Corp.,
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T. M. HUSHEN, Manager,
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Salt Lake City, Utah

E. H. Myers: This approach to "planned maintenance" is so reasonable and logical that it must be adopted by all major producers in time.

Electrical machinery manufacturers recognized the importance of maintenance and repair downtime to the steel producer and adopted many features in their machines to facilitate and reduce this work. A few of these features include:

1. The use of *completely* interchangeable rotors for all generators of the same ratings on a customer's motor-generator set regardless of their position on the sets. This requires larger bearings and pedestals than necessary on some generators but the obvious advantages to

the customer outweigh this consideration.

The same *complete* interchangeability of rotors is furnished on all motors of equivalent ratings on a mill regardless of whether they are single-armature, double or triple-armature, twin drives or a combination of these.

Consideration of the "spare" problem during the mill planning stage may indicate the advantage of furnishing a larger motor than needed on some stands just to obtain duplication of advantages. It is the duty of the electrical manufacturer to seek out and offer such advantages.

2. Design of machine internal parts made to give not only greatest protection from failure but also maximum accessibility for inspection, cleaning and repair. Some of these include:

(a) Armature cross connections made up of several thin flexible laminations per conductor firmly held to avoid fatigue failures. These are properly located at the rear of the armature for easy accessibility.

(b) Reversing mill thrust bearings designed to be entirely separate from the journal bearings to furnish maximum ease of inspection and adjustment.

(c) Endbells with extra large "snap-off" covers which can be removed in seconds leaving only a skeleton frame work. Where space permits walk-in doors are provided. Now the usual practice is to provide designs which permit the entire endbell to be lifted away in a minute or so after merely raising by hand a couple of cam levers.

(d) Baffles in the commutator area are carefully avoided to permit access and a clearer view of the rotor and field areas from the commutator end.

(e) Special devices to aid inspection and maintenance such as catwalks, interior lights, split pedestal caps in restricted areas and other custom designs to fit each individual application.

The author's use of the d-c overpotential tester emphasizes the growing popularity of this method. It is now generally well accepted that the single direction ionization with d-c in good insulation offers much less risk of damaging acceptable insulation than does a-c. On the other hand, it must also be admitted that an insulation failure during the application of the d-c overpotential test is generally more destructive than with a-c.

This method of testing offers much if it is carefully done and the results properly analyzed. For instance, the current resulting from a d-c overpotential is made up of two components, an absorption current and a conduction current.

The most important component of current for evaluating the condition of the insulation is the conduction portion of the total current. This component is determined by the type of insulation; its condition with regard to holes, cracks, surface creepage paths and carbonized areas as well as by the magnitude of the applied voltage. If the insulation is in good condition this component of current will vary fairly linearly with the voltage applied and does not appreciably change with time while the voltage is impressed. If the insulation is not in good condition the current may rise linearly with the increase in voltage up to a critical level, but after that point it will rise at an ever increasing rate for each increment of increase in voltage. This precipitous increase in current is sure evidence of incipient trouble.

The other component, the absorption current, immediately rises to a high value when the voltage is applied and then decays in an exponential manner as time passes. The value of this current at any particular instant depends on the size of the winding, its insulation, insulation thickness, the voltage impressed and the length of time that has passed after the application of the voltage level.

This component must be controlled and separated so that it does not obscure the really indicative component—the conduction current. For this reason the d-c overpotential test should be carefully applied over carefully chosen time increments and the results properly plotted to indicate incipient failures. A thorough discussion of the proper procedure would be too long to give here but several AIEE papers are available on this method. These include:

1. Corrections for Dielectric Absorption in High Voltage D-C Insulation Tests" by F. R. Schleif, AIEE Trans, Vol 75, Part III, August, 1956.
2. "D-C Testing Experience of Rotating Machine Insulation" by J. F. Johnson and A. W. Zwiener, AIEE Trans, Vol 76, Part III, August, 1957.
3. "Separation of Absorption and Leakage Components in High Voltage D-C Insulation Testing," by F. R. Schleif and L. R. Engvall, AIEE CP-58-204, Winter General Meeting, February, 1958.

T. M. Hushen: One outstanding fact is the thoroughness of the planning at Geneva, not only from a technical standpoint, but also from an economic standpoint, which is equally as important. This program is based on sound concepts which, all too often, are not generally recognized:

1. The "productive" value of a unit is the only sound criterion to properly judge the extent to which money should be invested in a maintenance program. Should we go along with no spares and no reconditioning? Should we stock some spare coils? Should we stock complete sets of coils? Should we carry a spare armature, a spare stator or a complete unit? These are questions that have to be answered after analyzing the "productive" value of a piece of equipment.

2. That no individual electrical test will give assurance of the reliability of an insulation system. Visual inspection, age, operating and atmospheric conditions; these plus a battery of tests all have to be combined to reach a halfway reliable estimate.

3. The manufacturer of the equipment should be a part of such a maintenance program. Large savings can be made by redesigning units to fit several applications. The author points this out on the 9800-hp synchronous motor, which is used to act as a spare for three motors; again, where *one* spare generator was designed to fit eight locations and two voltage ratings.

In past years, maintenance personnel concerned themselves with "preventive" maintenance methods. Modern maintenance cannot be satisfied with this approach. As previously pointed out, the *cost* of maintenance in a productive operation is not necessarily in the cost of repairs, but in the loss of production. Therefore, modern maintenance must anticipate failures and do the planning and preparing for such failures before they occur.

The program being carried out by Geneva Works can be considered a classic example of such modern maintenance thinking. ▲

Maintenance in the Steel Plant

. . . . the key to successful maintenance is preplanning, inspection and cooperation between maintenance and operating departments . . . .

"ENGINEERING MAINTENANCE"

by STEPHEN KRAFT
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Great Lakes Steel Corp.,
Div. of National Steel Corp.
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AN organization planning to build a unit, facility or plant, generally predetermines the degree of maintenance that will be required in its future equipment by the thoroughness with which strength, quality and durability are designed into the equipment. Almost equally important is the planning of its future maintenance facilities.

Major errors in this phase of plant development have caused a well intentioned management to scramble for years to make a quality product at the lowest cost, leaving in the wake of this frantic effort dissatisfied people who feel they are bearing the onus of *someone's* failure. In most cases management has at its disposal means of minimizing such major errors, that is by using the talents of the people they have available.

Management fails and does itself a disservice in not taking advantage of any knowledge that their key personnel, operating and maintenance staff as well as engineering may have. This does not imply consulting a large unwieldy force, but it means delegating the planning to a nucleus of five or six people, having the privilege and common sense to call around them, with each type of problem, the most able people in the organization, or for that matter to be able to call on any services available.

Great Lakes feels particularly fortunate that its top management practices this approach. As an illustration —Great Lakes top management selected a "basic task force" for planning the new 80-in. hot strip mill. This force actually consists of six people, three top level operating people and three engineering people. The task force was instructed to plan the most modern mill in the industry. This mill was to produce the best quality steel at the lowest cost. The task force proceeded to define the general requirements of such a plant—being guided by top management and key personnel in the Great Lakes plant and the National Steel Corp.

The task force felt to meet its obligations, this mill must produce the finest quality of steel at, not only, top speeds now attainable but must reach out into ranges of speed not yet tried. The most exacting width and gage criteria had to be set as a basic aim. These requirements meant minimizing roll and stand deflections, meant more powerful and responsive screwdowns and motors, meant more powerful mill motors with minimum droop and practically perfect speed control. A speed control that would maintain these desirable qualities in the full range of product produced; this meant building furnaces with actual practical capacities to heat 30 ft long slabs with proper soak to proper rolling temperatures. This meant better and more reliable edgers, scalebreakers, descaling equipment, crop shears, tables and coilers. "All of these items had to be built in proportions and with facilities to minimize maintenance requirements and mill delays."

This imposing definition was reviewed by many of the plant people and checked against the best mill operations in the country. With some additions, the management accepted this general specification as a starting point in their discussions with mill builders. It would be unfair to say that all the mill builders at first thought we were sane and practical.

With the assignment of the general mechanical and electrical equipment the task force and the engineering and management facilities of Great Lakes went to work. Although this job is not yet done, these are some of the steps and methods that were taken to insure that this 80-in. mill could run *faster, better* and *longer*. In other words this was when the detailed efforts of engineering-maintenance into this mill began.

It was considered necessary that sufficient capacity, mechanical as well as electrical, be installed in the train for any one stand to be *out* without appreciable loss in tonnage.

With this advantage a planned inspection of spindles, spindle carriers, pinion stands, gear reducers and mill

motors would be possible. Above all this work could be planned as a week-to-week maintenance job.

It was considered necessary that run-out table rolls be integrated cells—with rolls, guides, motor and guards all mounted on a common frame—all of which could be removed by a crane after six elementary moves. The built-up replacement would take the same number of steps to reinstall. Such planned replacements could be made during an ordinary roll change.

It was considered necessary that three coilers be designed for 1000 lb per lineal in. capacity and each coiler be retractable. Each coiler would have its own discharge equipment and conveyor. Each coiler could be shutdown, retracted from under its table, repaired, adjusted, greased and inspected with no operating hazards. With this facility, coilers could be maintained for high performance levels during their operations with less total maintenance.

It was considered necessary that all vertical edgers be top driven to minimize damage by scale and water.

It was considered necessary that crane facilities be provided over the furnace area to facilitate recuperator repairs as well as any furnace repairs and clean-out.

It was considered necessary that areas under the mills and behind them be sloped, that jets be provided to wash generated scale into flumes running parallel to the mill and discharging into a scale pit outside of the mill building. The scale pit was to be provided with a skeleton building, crane, pumping facilities, overflows and weirs. The scale pit was to be divided so one half could be cleaned while the other half would be operating. Incidentally, all the flumes are to be lined; those in the heavy scale area with high abrasion resistant liners and others with medium liners. Flumes are to be provided with walkways and monorails. Jets are to be spaced at intervals depending on quantity and nature of the scale.

It was considered necessary that spindle carriers be designed for a quick change of both top and bottom spindles. Each spindle carrier is to be mounted on heavy steel pads facilitating complete carrier replacement in case of damage.

It was considered necessary that every possible effort be made to standardize parts, gears, guides, rolls and table line shafts were studied to minimize varieties.

It was considered necessary that liners be requested for all bearing areas and on chocks of hardness in excess of 200 Brinell to avoid galling. Each liner, whatever the service, is to be double-locked.

Since this mill will have a 54-in. x 72 in. bearing used on a 60-in. diam backup, work rolls of 44-in. diam in the rougher and 28½-in. diam in finished stands (with provisions to increase these dimensions slightly), with housings of 1000 sq in. cross section per leg, this should be a mill with unusually low deflections and high safety factor.

It was considered necessary that all lubricating and hydraulic systems be provided with spare pumps. Temperature and pressure alarms are to be provided not only at each tank but in a central basement control room as well as on the mill floor.

It was considered necessary that special attention be given to each oil tank for easy removal of pumps, steam coils, valves, filters, etc. Also that substantial provisions should be made for cleaning each tank. Incidentally, all hydraulic systems are to be operated with fire-resistant oil.

It was considered necessary that all roll table drives be lubricated by a circulating oil system, that a fully equipped bearing stripping and repair area be provided with degreasing equipment with racks, flattables, jibcrane and all necessary tools for bearing repairs.

A centralized storehouse is to be provided where all spare parts, maintenance and operating supplies as well as miscellaneous hand tools could be cataloged and stored. A central shop area is to be provided with all utilities and facilities for all repairs exclusive of machining.

This random selection of ideas that have been presented illustrating the effort to design quality equipment with facilities to minimize maintenance represents only a part of the job done. It would be no exaggeration to say that even nuts and bolts have been carefully scrutinized for quality and long service. Unreserved praise must be extended to the mill builder for their fundamental designs. However, this type of approach is the way one can engineer a good plant, minimizing future problems and providing a good maintenance performance.

"THE SELECTION OF CONTROL COMPONENTS FOR EFFECTIVE MAINTENANCE"

by IVAN AKEY
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Great Lakes Steel Corp.,
Div. of National Steel Corp.,
Ecorse, Detroit, Mich.

THE present trend to adapt computers to monitoring and controlling processes has pushed the need for a change of thinking habits on the part of control engineers to graduate from the present day "standard size" instruments and control systems to the realm of "miniatures" and "electronic brains."

It is necessary to examine the process from every available point of view in order to design a suitable control system. The engineers must point out what variables are involved in a process; the operator must determine what reactions are necessary for the best process results; and the control people must develop the equipment which will produce the necessary combinations of the various reactions. The maintenance people have a problem too, and that is to look very closely at the servicing of control components to be sure that maintenance may be most effective.

One of the decisions to be made in the selection of controls is to determine the medium with which to transmit impulses from one point to another. There are four such media; namely: (1) mechanical linkages, (2) pneumatic signals, (3) hydraulic signals and (4) electrical signals. The latter, electricity, has some very distinct characteristics as follows: (1) with processes being speeded up, and being subjected to tighter economic restrictions, more results must be obtained and more quickly, electricity fits these conditions as it is the fastest of these media; (2) electricity is the one medium which in its natural state comes to us clean enough to use without any processing necessary (voltage and current regulation compare to similar requirements for

other media); and (3) interconnections made of wire do not have as much susceptibility to deterioration and leakage as pipes or tubing.

The next step is to consider the locations of the various components on the process equipment. The installation characteristics of primary sensing elements is usually dictated by scientific calculations and other predetermined criteria. The impulses from these primary elements should all be reduced to a single medium, with as many duplications of characteristics as possible, for the purpose of simplicity in the over-all scope of the control system. Converters and transmitters used in this fashion should be located as near as possible to the primary elements; however, some deviations from this exactness may be necessary if it is then possible to mount a group of them on a localized rack arrangement. Locations for balancing units (or ratio controls) may be either in the field or in a centralized control house; this choice depends on the proximity which is required between these and their more closely inter-related components for good maintenance. Recording units should be located on a panel where performance observations, set-point changes, and other operating adjustments can be made.

Panels should be designed so that an absolute minimum of maintenance adjustments are accessible from the front. The reasons for this are two-fold; first, to avoid congestion between operating and maintenance personnel traffic; and second, to minimize the possibility of unauthorized personnel unwittingly fouling up any adjustments. Another consideration which should be given to panel design is accessibility to all pieces of equipment; because of this, the console arrangement *can* create complications and disadvantages. Also, in view of the accessibility factor, beneficial advantages may be gained by mounting some of the equipment on remotely located racks.

Emphasis should be placed on the necessity of locating components in vibration-free and clean areas. This may mean using suspension platforms in some cases, and the installation of air-conditioning equipment in others.

The control operators should be located so that they are accessible from a platform or floor, and so that maintenance personnel can get to them. Also, they should be removable without having to dismantle any other equipment or structure.

When a control system is being planned, a geographical survey should be made to determine any needs for effective communications. Accurate results of comprehensive inspection service depend on instantaneous knowledge of conditions in most instances; hence, if inter-related components have to be separated geographically, it becomes necessary to have phone communications adjacently available to each unit rather than having to rely on the old fashioned method of hand signals. These phones should be of such a style that no hands are needed for their operation; this will make more manual productivity available from maintenance personnel.

In order to quickly and accurately determine proper or improper functioning of controls, provisions must be made in advance for the installation of test gages, dials, meters, etc., which may be permanently installed, or may be connected at will for temporary use. Making sure that the proper information is recorded is a big help in finding trouble. Annunciators also contribute much to the success of accurate performance analysis.

After improper performance has been detected, adjustments and/or repairs become the next order of business. The most effective maintenance is reflected by the ease and/or speed of returning controls to their proper performance characteristics. Rapidly interchangeable, or plug-in components contribute very much to this problem; in fact, field work should consist of inspection service, very minor adjustments, and replacement of faulty equipment. A unit which requires more than just a few manual manipulations to restore to proper condition should be removed and the spare "plugged in." Repairs, replacement of internal parts, and calibration, should all be done in the shop.

Three more aids in effective maintenance planning are; (1) control diagrams, (2) instructions and (3) training. Schematic diagrams should be made up to show the cuts of the control components in proper sequence, and hook-up arrangement, so that both the inter- and intra-functioning can be determined simultaneously; this can be a big help over and above the normal engineer's print or wiring diagram. Instructions should be written in such a manner that the functioning of the components in the process is explained along with how the internals of the unit perform. The use of language is of extreme importance in this day and age, one talks about a "servo-mechanism," how often is this term reduced to the language of a layman? Instructions need to be designed to fit every detail of each particular application, both technical-wise and personnel-wise. Training is one area in which much advancement must be made. Knowledge is available in advance concerning new control systems which are to be installed. Time should be allotted during this advance period for development of a suitable training program for maintenance personnel. If a person knows the "what," "why" and "how" about a control system, one can then expect more effective results from him, and from the equipment.

It has been pointed out how the composite thinking of engineers, operators and control people is necessary in order to plan an effective control system. After a system has been designed, installed and put into operation (on a furnace, for instance), it is necessary for the heater and instrument repairman to work "hand in hand" in order to realize proper and uninterrupted performance of the equipment. In other words, they must put their heads on each other's shoulders, talk over their problems, come to a common understanding, arrive at a logical solution, plan their course of action and then put it into effect.

"CO-ORDINATION OF OPERATING MANAGEMENT, ENGINEERING & MAINTENANCE"

by FRANK L. BRUNNER
Manager, Service Div., Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich.

TO co-ordinate operating, engineering and maintenance into an efficient operating team is essential to be able to maintain and operate the equipment at maxi-

mum production, with minimum delay and cost.

It must be remembered in all instances, safety and housekeeping standards must be maintained at all times. Maximum operating and maintenance efficiency cannot be obtained without the highest safety and housekeeping standards being established.

Co-ordination is best accomplished through joint counseling wth all units involved, having each responsible for a definite part in the projection and planning of the program. In order to accomplish this one must first have top management recognize the advantages and dollars saved through a good preventive maintenance program. At Great Lakes Steel, this is in effect.

Second one must have the operating personnel recognize the additional productivity available with preventive maintenance eliminating breakdown delays and providing uninterrupted operation.

With this accomplished one now not only has the backing of top management, but will have the operating manager insisting that the best possible preventive maintenance program be provided for his mill.

There is only one way to properly co-ordinate operating, engineering and maintenance supervision. That is, through joint counseling, each must be responsible for a definite part in a specific schedule for operating and maintaining equipment.

With this in mind, Great Lakes Steel has setup the following procedures: Where equipment changes are being considered or performance is being questioned, the operating, engineering and maintenance supervision jointly inspect the operation and counsel each other on a solution for the problem.

Through their combined analysis and deductions a recommendation is made to management. Using this procedure the operating manager is assured that all recommendations have been investigated by his operating, maintenance and engineering supervision. It then becomes the responsibility of management to review the findings and weigh the economics of the results to be obtained.

On all new or major rehabilitation, the engineering department is in charge of the construction. Operating and maintenance supervision, responsible for the operation and maintenance of the equipment, is required to follow the installation to completion. In this way they become familiar with all details and observation is made with reference to the prints they have previously approved. Any operating or maintenance problem which becomes evident, may be rectified through joint review with operating, engineering and maintenance.

This is the first step of co-ordinating operating, engineering and maintenance supervision.

When plant personnel is used to make the installation, the engineering department furnishes the detailed engineering and then jointly with the operating and maintenance supervision projects the progression of the job. A chart is made showing the required man power and estimated date of completion, which is reviewed each week with operating, engineering and maintenance supervision. This provides the mortar which cements the team together. Unity and order now replace division and confusion.

On regular daily, weekly, monthly and yearly repairs and inspections, a weekly meeting is held with the operating and maintenance supervision to project the production and maintenance schedules for the coming week. Production requirements must be substantiated with reference to maintenance required. Through this medium, maintenance supervision knows the production requirements and operating supervision understands the maintenance required for their equipment to continue to operate trouble free. This also provides a means for operating and maintenance supervision to discuss their problems and agree upon a solution.

It is the routine, repetitive maintenance program, however, which is the most difficult to maintain. A major breakdown which has production stopped will always receive top priority and in most cases, production will be restored in record time. But when it comes to making a routine inspection which may require co-ordination of operating and maintenance schedules, to provide the needed downtime, it is not always given proper priority and results in lost production later, due to an unpredicted breakdown.

With the operating and maintenance supervision jointly projecting their operating and maintenance schedule each week, this type of delay is minimized.

In many cases when a routine procedure must be followed in the starting up or shutting down of a piece of equipment, a form is provided for the supervisor to check off each step and have it signed by all who are responsible for the various steps performed. It is most important here, that a definite time be indicated where the equipment is turned over to the maintenance personnel for repairs and a time where maintenance releases the equipment back to the operating supervision.

As an example, in the open hearth furnace repair program, a uniform procedure is established for the senior masonry foreman and senior melter to follow in lighting up a furnace immediately upon completion. This procedure was setup through joint counseling with the operating and maintenance supervision. Upon completion of the final draft, the director of safety, general superintendent of the open hearth, managers of maintenance, superintendents and general foremen of all crafts and labor involved were required to sign their name, in approval of the procedure.

Figure 1 — Reports such as this indicate furnace conditions.

JUNE 11, 1959

FURNACE PROGRAM FOR COMING WEEK

NO. 17 FURNACE - 93 HEATS - TO BE TAKEN OUT OF SERVICE ON MONDAY, 6-15-59, FOR A FLAT SILICA ROOF ONLY.

HOT WORK

NO. 1 FURNACE - 68 HEATS - FRONT ROOF TO BE CHECKED FOR PATCH.
NO. 16 FURNACE - 88 HEATS - PATCH WEST END BEFORE NO. 17 COMES DOWN.

NO. 29 HOT METAL CAR BEING RELINED. NO. 27 & NO. 28 TO FOLLOW.

FIVE (5) LADLES TO BE RELINED AT NO. 1 OPEN HEARTH.
FOUR (4) LADLES TO BE RELINED AT NO. 2 OPEN HEARTH.

NO. 1 SOAKING PITS - NO. 1 BLOCK, NO. 3 BLOCK, AND NO. 11 BLOCK TO BE BACK IN OPERATION AS SOON AS POSSIBLE. PRESENTLY WORKING ON NO. 5.

NOTE: NO. 6 FURNACE DOWN FOR A RECONVERSION TO BASIC FURNACE.

J. TOHALL
SUPT., MASONRY DEPT.

DATE - JUNE 12,1959 — NO. 17 FURNACE REBUILD SCHEDULE

JOB DESCRIPTION	DEPT. & SUPERVISOR	TURN -1	+1	2	3	4	5	6	7
INSTALL SAFETY AND WORK LIGHTS	LABOR - KERAMIDAS	X							
	ELECTR. - GALLON	X							
CLEAN AREA	OPEN HEARTH - MELTER	X							
STRIP DOORS & FRAMES, TIE UP HOSES	MILLWRIGHTS - BUTLER		4						
CHARGE FURNACE	OPEN HEARTH - MELTER		3						
PUT IN BOXES	LABOR - KERAMIDAS		1	1					
KNOCK IN ROOF	LABOR - KERAMIDAS			2					
REMOVE BOXES	LABOR - KERAMIDAS			2					
HAND CLEAN BATH	LABOR - KERAMIDAS			3	5				
PUT ON FRAMES	MILLWRIGHTS - BUTLER			1	3				
INSTALL BATH SCAFFOLDS	CARPENTERS - DOUDT				2				
KNOCK DOWN FRONTWALL AND TRIM	LABOR - KERAMIDAS				4				
HOOK UP FRONTWALL BUSTERS	LABOR - KERAMIDAS			2					
REMOVE END FRONTWALL COOLERS	PIPEFITTERS - WILLIAMS				2				
INSTALL FRONTWALL AND SKEW BACK	MASONRY - CRAWLEY				1	4			
BLOW ROOF	McGILL - RIGGERS				1				
INSTALL ROOF CENTERS	CARPENTERS - DOUDT					6	2		
PUT ON ROOF	MASONRY - CRAWLEY						8		
STRIP CENTERS	CARPENTERS - DOUDT							3	
UNDER PIN ROOF	MASONRY - CRAWLEY							3	
CLEAN BATH	LABOR - KERAMIDAS							4	
DRESS BANKS AND BRIDGE WALL	LABOR - KERAMIDAS							4	
PUT ON DOORS	MILLWRIGHTS - BUTLER							4	
RESET LADLE STAND	RIGGERS - McGILL		4	8	8	8	8	8	
REPLACE FLOOR & RAILS IN FRONT PCE.	LABOR - KERAMIDAS							8	8

Figure 2 — Open hearth furnace rebuild schedule is here shown for 500-ton furnace.

In addition to this, a standard check list is used showing in proper sequence each step to be inspected or operated and approved previous to light up. Furnace being found in proper condition, check list is signed by the senior masonry foreman and senior melter, showing date and time of acceptance by the operating supervision.

At the weekly open hearth furnace rebuild meetings, the superintendent of masonry who is in charge of all furnace repairs, presents a furnace program for the coming week.

The condition of all the furnaces is reviewed along with the condition of other equipment, such as hot metal cars, ladles, soaking pits and major or reconversion projects that may be in progress (Figure 1).

A detailed inspection of the furnaces has been made jointly by the operating and maintenance supervision previous to the meeting. With this information and joint counseling, the operating and maintenance schedule for the coming week is setup with the highest degree of efficiency.

Figure 2 shows an open hearth furnace rebuild schedule. This is for a 500-ton furnace. The sequence of the work has been identified. The labor or craft and supervisor responsible for doing the work has been identified. The time required and turn has been scheduled. This particular schedule called for seven turns with the gas in the checkers on the sixth turn. Actually this was improved by eight hours.

Figure 3 is a weekly projection of construction work. The per cent of progress is shown. The date of completion is shown.

Figure 4 shows the distribution of the electric construction force required to man the construction schedule.

In Figure 5 a particular construction job is detailed showing the proper sequence of progression. This is a very critical area and should be given careful consideration.

A schedule of crafts is shown in Figure 6 in proper sequence. Manpower requirements are also shown and proper sequence of craft on the job is indicated.

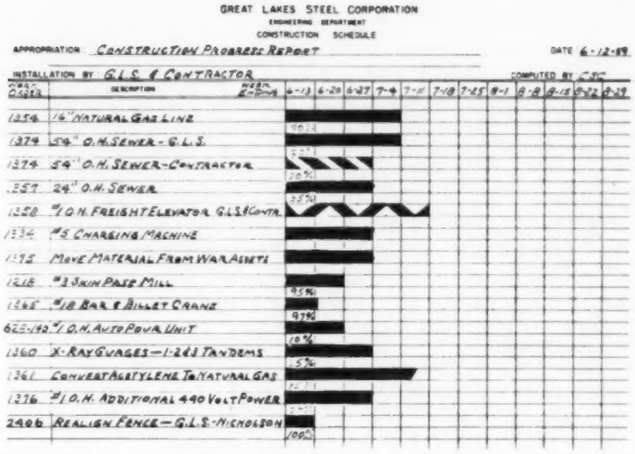

GREAT LAKES STEEL CORPORATION
ENGINEERING DEPARTMENT
CONSTRUCTION SCHEDULE
APPROPRIATION CONSTRUCTION PROGRESS REPORT
DATE 6-12-59
INSTALLATION BY G.L.S. & CONTRACTOR
COMPUTED BY J.S.C.
1254 14" NATURAL GAS LINE
1379 54" O.H. SEWER - G.L.S.
1379 54" O.H. SEWER - CONTRACTOR
1257 24" O.H. SEWER
1258 #1 O.H. FREIGHT ELEVATOR G.L.S. CONTR.
1334 #5 CHARGING MACHINE
1375 MOVE MATERIAL FROM WAR ASSETS
1218 #3 SKIN PASS MILL
1265 #18 BAR & BILLET CRANE
625-142 #1 O.H. AUTO POUR UNIT
1360 X-RAY GUAGES - 1-2&3 TANDEMS
1361 CONVERT ACETYLENE TO NATURAL GAS
1376 #1 O.H. ADDITIONAL 440 VOLT POWER
2406 REALIGN FENCE - G.L.S.-NICHOLSON

Figure 3 — A weekly projection of construction work is made up.

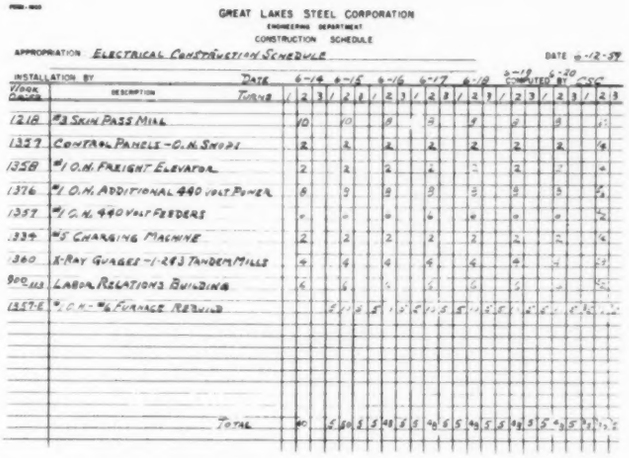

GREAT LAKES STEEL CORPORATION
ENGINEERING DEPARTMENT
CONSTRUCTION SCHEDULE
APPROPRIATION ELECTRICAL CONSTRUCTION SCHEDULE
DATE 6-12-59
INSTALLATION BY
COMPUTED BY J.S.C.
1218 #3 SKIN PASS MILL
1327 CONTROL PANELS - O.H. SHOP
1358 #1 O.H. FREIGHT ELEVATOR
1376 #1 O.H. ADDITIONAL 440 VOLT POWER
1357 #1 O.H. 440 VOLT FEEDERS
1334 #5 CHARGING MACHINE
1360 X-RAY GUAGES - 1-2&3 TANDEM MILLS
900-113 LABOR RELATIONS BUILDING
1257-E #1 O.H. - #6 FURNACE REBUILD
TOTAL

Figure 4 — Manpower distributions are made to suit construction schedules.

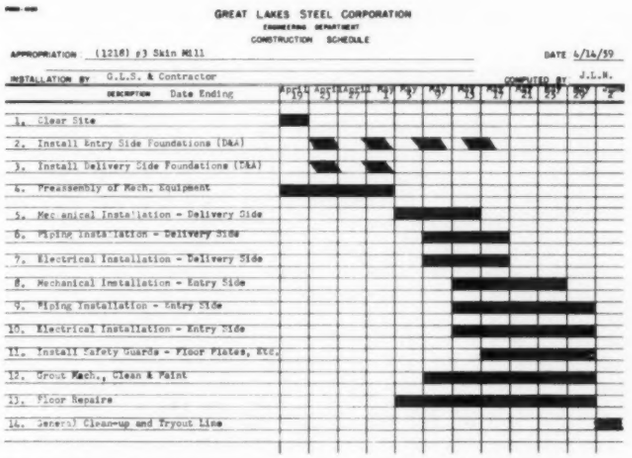

GREAT LAKES STEEL CORPORATION
ENGINEERING DEPARTMENT
CONSTRUCTION SCHEDULE
APPROPRIATION (1218) #3 Skin Mill
DATE 4/14/59
INSTALLATION BY G.L.S. & Contractor
COMPUTED BY J.L.N.
DESCRIPTION Date Ending
1. Clear Site
2. Install Entry Side Foundations (D&A)
3. Install Delivery Side Foundations (D&A)
4. Preassembly of Mech. Equipment
5. Mechanical Installation - Delivery Side
6. Piping Installation - Delivery Side
7. Electrical Installation - Delivery Side
8. Mechanical Installation - Entry Side
9. Piping Installation - Entry Side
10. Electrical Installation - Entry Side
11. Install Safety Guards - Floor Plates, Etc.
12. Grout Mach., Clean & Paint
13. Floor Repairs
14. General Clean-up and Tryout Line

Figure 5 — Sequence of jobs is shown by schedule.

This particular phase takes much study on the part of the project engineer. Each craft is anxious to start and complete his part of the work as soon as possible and in many cases has difficulty in understanding why he must wait or move out of an area to make room for a different craft. It is most difficult to have the different crafts recognize and evaluate which craft should have priority over the other in the different phases of the job progression.

This again is where joint counseling and planning

GREAT LAKES STEEL CORPORATION

ENGINEERING DEPARTMENT

CONSTRUCTION SCHEDULE

APPROPRIATION (1218) #3 Sain Pass Mill — DATE 6/24/59

INSTALLATION BY G.L.S. & Contractor — COMPLETED BY J. L. H.

DESCRIPTION	Date Ending	Apr 10	Apr 17	Apr 24	May 1	May 8	May 15	May 22	May 29	June 5	June 12	June 19	June 26	July 3
	#1 Turn	10				5	5	5	5	5	5	5	5	5
Labor	#2 Turn	10	5	5	5	5	5	5	5	5	5	5	5	5
	#3 Turn	10	2	2	2	5	5	5	5	5	5	5	5	5
Carpenter	#1 Turn	2	2	2	2	6	6	6	6	6	6	6	6	6
	#1 Turn	5				5	5	5	5	5	5			
Riggers	#2 Turn	5	5	15	15	15	15	15	15	15	15	15	15	15
	#3 Turn	5		5	5	5	5	5	5	5	5	5	5	5
Pipefitters	#2 Turn	5	5	5	5	5	15	15	15	15	15	15	15	15
	#3 Turn	5					5	5	5	5	5	5	5	5
Electricians	#1 Turn	5					5	5	5	5	5	5	5	5
	#2 Turn	5	5	5	5	5	20	20	20	20	20	20	20	20
	#3 Turn	5					5	5	5	5	5	5	5	5
	#4 Turn					3	3	3	3	3	3	3	3	3
Welders	#2 Turn		4	4	4	4	6	6	6	6	6	6	6	6
	#3 Turn		1	1	1	2	4	4	4	4	4	4	4	4
Painters (As Required)														
Millwrights (As Required)														
Shop Work (As Required)														

Figure 6 — Allocation of job to group requires detailed study.

Repair and Maintenance Expenditures vs. Total Manufacturing Costs
(Nine Largest Steel Companies)

Years	Total Mfg. Cost (Millions)	Repairs and Maintenance (Millions)	% R. & M. of Total Mfg. Cost
1946	$ 3633.1	$ 400.0	11.0
47	4930.8	568.5	11.5
48	5918.4	727.4	12.3
49	5404.3	727.5	13.5
1950	6488.6	807.1	12.4
51	7773.6	1012.7	13.0
52	7636.9	936.0	12.3
53	8868.0	1195.5	13.5
54	7381.6	953.6	12.9
1955	9045.7	1119.9	12.4
56	9916.6	1288.0	13.0
57	10241.6	1463.4	14.3
12 Yr. Totals:	$ 87,239.2	$11,199.6	12.8

*Source: Securities and Exchange Commission Statements.

Figure 7 — Maintenance cost has steadily risen as per cent of manufacturing cost.

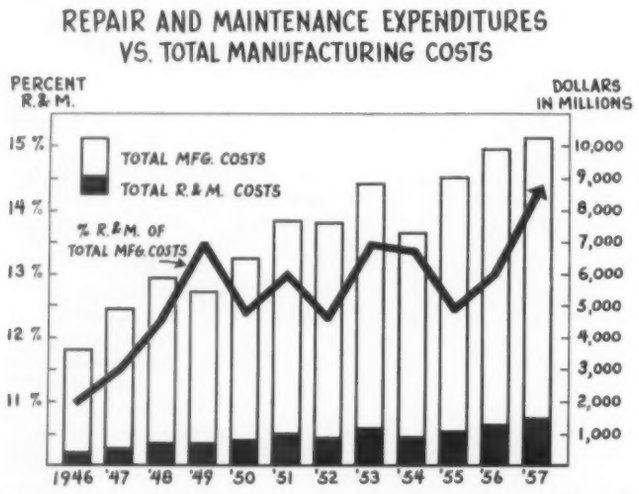


Figure 8 — Chart shows breakdown between repair and maintenance expenditures for total manufacturing cost.

will bring forth understanding and harmony, which will promote the highest possible degree of efficiency on the job.

Where the construction project interferes with other production units or depends on the use of certain production equipment, the use of co-ordinators from the production personnel have been utilized to provide maximum production with minimum loss of efficiency on the construction project.

MASONRY AND LABOR HOURS COMPARISON - OPEN HEARTH FURNACE REBUILDS

FCE. NO.	% IMPROVEMENT: TOTAL MASONRY HOURS	% IMPROVEMENT: TOTAL LABOR HOURS	JOB DESCRIPTION
X_1	BASE	BASE	COMPLETE ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.
X_2 *	26.4	36.6	COMPLETE ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.
X_3 **	32.7	61.7	COMPLETE ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.
Y_1	BASE	BASE	MAIN ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.
Y_2 *	44.0	45.2	MAIN ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.
Y_3 **	53.1	66.7	MAIN ROOF, FRONTWALL, BACKWALL FROM SLAG LINE.

* AFTER REORGANIZATION.

** RESULTS OF DETAILED PLANNING & JOB PROJECTION — May 27, 1959 -- J. Toxell

NOTE CHECKERS & TUNNELS CLEANED ON ALL THESE JOBS.

Figure 9 — With planning there was a more effective use of masonry and labor man-hours.

Figure 7 shows the repair and maintenance expenditures vs total manufacturing costs based on the nine largest steel companies. The source of information are securities and exchange commission statements. The figures here are in millions of dollars.

The total manufacturing cost for the twelve year period from 1946 through 1957 was $87,239,200,000. The repairs and maintenance cost for the twelve year period from 1946 through 1957 was $11,199,600,000.

Figue 8 is a graph of the per cent of repair and maintenance dollars to total manufacturing cost. In 1946 these dollars represented 11 per cent of the total manufacturing cost. In 1957 they had increased to 14.3 per cent of the total manufacturing cost.

From this, one can see one must do all he can to improve over-all efficiency and reduce the cost of repairs and maintenance. The following figures indicate the per cent improvement that has been obtained through good planning and co-ordination of effort.

Figure 9 indicates the per cent improvement in masonry and labor man-hours required for open hearth furnace repairs. During the base period shown here the responsibility for open hearth furnace repair was divided between the operating, masonry and general labor departments, with no one co-ordinating the over-all job. This was recognized by management as being inefficient and the superintendent of masonry was placed in charge of all furnace repairs and co-ordinating all crafts required to complete a rebuild. Labor is assigned direct to the masonry department. A study was made of each repair job and a repair schedule projected for each job as shown in the previous slide. Almost immediately this 26.4 and 36.5 per cent improvement was made. In nine months the improvement was 32.7 and 61.7 per cent.

In 1957 we established a centralized maintenance system in our cold mill area. Detailed planning of work with regular lubrication and inspection schedules were set up.

The operating supervision in the cold mill is scheduled by section to meet weekly with the mechanical, electrical and shop maintenance supervision to project their operating and maintenance schedules. In addition to this

	% GAIN	
	PICKLERS	TANDEMS
TONS/HOUR	10.5	14.2
AVERAGE DELAY	37.5	22.3
TOTAL OPER. & MAINT. COST, $/HOUR	27.7	13.8
ASSIGNED MECH. MAINT. COST, $/HOUR	44.4	43.3
MECH. SHOP LABOR & MATERIAL COST, $/HOUR	6.7	24.5
UTILITIES - AIR, #/HOUR	-49.0	-10.0
STEAM #/HOUR	32.5	-10.0
WATER, GAL./HOUR	3.4	-57.0
ELECT., KWH/TON	-48.6	12.2
LUBRICANTS	-	7.3
SLUSHING OIL, GAL./TON	-	35.7

Figure 10 — Data shows improvement with planned maintenance comparing test periods of June through December, 1956, with January through June, 1959.

improved maintenance program, a study was made of operating equipment and improved facilities were installed.

Figure 10 shows the percentage of improvement realized from the improved equipment with planned maintenance. One can see from this, that the co-ordination of effort in planning, projecting and maintaining production and maintenance schedules will cut waste of materials, increase the efficiency of manpower and equipment will be able to produce more tons per hour.

"MAINTENANCE OF HOT METAL CRANES"

by R. H. EMMERT,
General Superintendent Blast Furnace, Coke Oven,
Open Hearth & Electric Furnace Maintenance
Steel Div., Ford Motor Co.
Dearborn, Mich.

ANYTHING in this presentation can be applied to any other overhead crane or for that matter any piece of equipment in any steel mill. The name hot metal cranes normally applies to cranes handling molten iron on the charging side of an open hearth furnace. At Ford's open hearth these cranes are rated at 125 tons which consists of 75 tons of molten iron and a 50-ton ladle.

The cranes in the pouring pit are called ladle cranes. They normally handle a ladle of molten steel which has a total weight of approximately 265 tons. Of this, 200 tons are molten steel at about 2850 F, plus the ladle which weighs 65 tons.

The maintenance department is charged with the responsibility of keeping cranes in good safe working condition to insure the safe handling of these enormous loads. Much could be said at this time to show the relationship between a well planned maintenance program and some of the safety records that have been set. Safety then goes hand and hand with a planned lubrication and inspection program, which is a necessity for any well organized maintenance department.

Worn equipment soon becomes unsafe; on a crane handling molten metal this cannot be allowed to happen. A very close check must be kept on the intricate electrical system and huge pieces of mechanical parts that go to make up the crane.

As soon as a piece of equipment is put into service, whether it be a $3,000,000 ladle crane or a bridge wall in an open hearth furnace it starts to wear out.

Lubrication and inspection then becomes the principal means of prolonging effective crane life, which in turn results in a more efficient operation and more tonnage.

At scheduled lubrication and inspection periods, detailed inspections are made of all mechanical and electrical equipment that cannot be made while crane is in operation.

The lubrication and inspections are performed by skilled tradesmen classified as millwrights and electricians. During the process of oiling and greasing they are constantly on the alert for any indication of trouble and immediately report their findings to their foreman. Because of the importance of this work, a foreman is required to be on the crane at all inspections. Most equipment failures give some warning of approaching trouble. It is these warnings that the maintenance man looks for. If it is minor in nature, the job is done at once. Taking care of the small troubles when found eliminates the possibility of their growing into major repairs. Also noted and logged at this time is information showing amounts of progressive wear which in turn indicate when it will be necessary to perform a major repair.

The logging of this information is very important because it is used to plan major repair work which will be timed and co-ordinated with production schedules. A large percentage of breakdowns can be eliminated by good inspection and good follow-up.

With the growing demand for steel, industry must find ways to create extra production economically from available facilities. One of the most annoying and costly barriers to full production is downtime due to breakdowns. When you can schedule the major jobs and eliminate unexpected failures you are reducing production delays, eliminating premium time and unnecessary damage to equipment.

To expedite and co-ordinate the major job requires considerable planning and teamwork. To accomplish this a meeting is setup with operators, maintenance personnel and safety engineers.

Operators, after reviewing their schedules, pick a time for equipment to be shutdown. This allows them to get their activity in best possible condition for shutdown and possibly change their production schedule to suit the anticipated outage. Safety problems that may arise are discussed in detail and safe job procedures are setup with the concurrence of the safety engineer.

The problem of storing all of the material and parts necessary to do the job is reviewed and areas assigned for this purpose. Communications to off-shift supervisors are prepared to alert them of the impending work.

All of the major work that has been planned at Ford in this manner has worked out very well with a minimum amount of overtime and a minimum or, in many cases, no loss of production.

Despite the dangerous nature of this type of work, there have been no accidents on any planned job. There is no doubt that the prejob planning has helped in this area.

A good maintenance program can also mean a reduction in inventory of expensive spare parts.

Close scrutiny of the log books and inspection reports allow the maintenance department to plan jobs far in advance of the time that equipment is nearing the end of its usefulness. This type of approach allows the maintenance activity to order spare parts closer to the time of their use than would otherwise be possible.

Another factor in inventory reduction is the reworking of worn parts. The rebuilding or reworking of worn parts can be accomplished by an assigned maintenance group only if time is available for them to do this type of work. It is entirely possible that this time can be made available if there is a good planned maintenance program in effect.

The mental and physical fatigue on your supervisors and hourly people is lessened. The elimination of the constant scrambling and confusion trying to repair unexpected breakdowns is practically eliminated. With the elimination of the unexpected breakdowns, the morale of supervisors and hourly personnel is raised to a higher degree than that present in a department that is doing their maintenance work in a haphazard manner.

One cannot exist on a motto of "let the next turn do it" "we will do it at the next time down" or "we will do it when we can get it."

This type of approach can lead to nothing but major disaster—loss of production, waste of manpower, confusion and ill feelings between operating and maintenance personnel.

With a planned program supervision in the maintenance unit cannot help but be in a better frame of mind. He will have more time to do some of the other important aspects of his job. He can plan ahead and get a better understanding of his cost problems. He can think of design changes to better his equipment. He can get his safety program in order.

The following is one of the more serious problems facing many maintenance groups in steel mills. With the use of oxygen in open hearth furnaces to increase production, without in most cases additional handling equipment, problems between maintenance and operating departments will increase in proportion to the increased tonnage.

Management must recognize that it is the maintenance department that keeps the equipment running and that they must have the authority to carry out their job in the best interest of safety, production and cost reduction.

Operators will have to plan their activity more thoroughly and take into account the time required for inspection and lubrication of their equipment.

Operating supervisors who have spent some of their training time in maintenance departments have acquired some recognition of the importance of maintenance work.

It is true that in most cases they know very little about the electrical and mechanical work necessary to keep a crane in good working condition. But in their contacts with maintenance, even on a broad general basis they have learned to recognize the necessity of good co-ordination.

It is our belief that before a man is classified as an operating supervisor he should spend some considerable time working in a maintenance department. Operating personnel whose early experience was concerned with maintenance are usually more cognizant of the importance of lubrication than those whose experience was in production only.

Eventually such a training system would develop a group of operating supervisors that would be maintenance-minded. Correspondingly, one of the requisites of a good maintenance supervisor is that he must be production minded—to a degree. He must know the true production value of every piece of equipment for which he is responsible.

With production-minded maintenance supervisors and maintenance-minded operating supervisors, there is the basis for a strong management team.

There is no program that will work effectively without a full measure of good human relations. No one individual or department can put this program over, but if everyone will support such a program, all will share in its benefits, and maintenance cost goes down while tonnage goes up.

"MAINTENANCE OF ROLLING MILL CRANES"

by JOHN HERTZA,
Superintendent, Rolling Mill Maintenance
Steel Div., Ford Motor Co.,
Dearborn, Mich.

CRANES are a vital piece of equipment in the steel industry. Without the use of cranes, it is doubtful whether a single ton of iron or steel could be produced. From the iron ore fields to the boat docks, and from the open hearth to the finished product, no matter what it may be, the crane plays a very important role.

Scheduling maintenance can be applied to any major piece of equipment whether it be a furnace, a mill or a continuous pickler. The theory of planning and scheduling maintenance was applied to our rolling mill cranes and this is covered in this paper.

In order to keep overhead cranes operating at maximum efficiency 24 hours a day and seven days a week, it is necessary to have some down-time to lubricate, inspect and repair. This made sense to all but no one could spare the time to shut the cranes down for fear it would hinder production, or when production was down the maintenance people needed the crane to repair the equipment and get it back into service. There was never time for the crane. It had to keep going at all costs. A mill or furnace could be scheduled down for repairs for one shift or one day but not the crane, it had to keep operating for the maintenance department to complete the repairs on time. The question was, when would the crane get its rightful share of attention?

For a time, it was possible to get by because we were not operating at 100 per cent capacity and the maintenance department used all of its ingenuity to make the best use of the little time that cranes were available. It was a constant struggle to persuade the operating people to release a crane for proper maintenance, but it

was done. As a result, most of the work was done on week-ends or at the expense of premium time.

This went well under the circumstances until the mills began stepping-up production and were scheduled for seven days a week or near capacity operations. This reduced the available time for the cranes even more and as a result crane breakdowns were more frequent. The greatest objection was that it seemed the crane would breakdown at the most critical time when operations needed it most. This always seems to be the case on most equipment when it breaks down, it never happens at an opportune time but always at the wrong time. Production always suffers. The crane repair department continued pointing out to the operating people that it was about time they were given the cranes for proper maintenance to avoid these frequent breakdowns. As usual, the operating people could not see how they could release the cranes for maintenance and still keep up their production. Actually, when a crane was out of service, production continued as usual for at least an hour or better. At times like these, the operating department would use their ingenuity and some-how someway keep production going at all cost. They seemed to manage somehow by using one of the other cranes, or improvising by other means. This was something we could never understand, if they could do it from necessity, why could they not do it voluntarily?

We could not very well blame the operating people too much because they had a job to do. The only things lacking were the complete understanding of one another's problems and complete co-operation. How could we get the operating department and the maintenance department closer together? The answer was to get top management, to whom both departments were responsible, to understand the problem and accept the recommended solution.

The attempt was made. A crane inspection and lubrication schedule was presented to top management. One may ask why this schedule, and what was the purpose of it. There were definite objectives in mind and they were; (1) To maintain all cranes in the best possible operating condition, (2) To assist operating supervision to attain maximum production with a minimum of downtime. In other words, it was intended to provide the best mechanical and electrical service necessary to enable the operating unit to operate equipment at the most efficient rate, and produce at the lowest possible cost, consistent with safe operation.

The idea of crane inspection was not new, it had been done all along; but, what was new was the idea of successfully scheduling this inspection. The real secret of the schedule's success was that it had to be rigidly adhered to. No one should be allowed to deviate from it and everyone has to live up to it. This does not mean that we did not allow for emergencies, or that we were not flexible enough to allow for a reasonable request to make a change providing enough advance notice was given and satisfactory changes could be made. This only meant that whatever agreements were reached, the crane would be inspected and lubricated according to the new schedule. This was the help sought from top management, the agreement to try it. There was agreement between operating departments and the maintenance departments, that each could live up to their individual obligation and make the program work. Thanks to the fine co-operation displayed by all concerned, the crane inspection and lubrication schedule was put into effect in 1956 and it is still operating successfully to date.

In the rolling mills there are a total of 50 overhead cranes, ranging from 5-ton to 50-ton capacity and anywhere from 2 to 39-years old. The average crane is of 20-ton capacity and 25-years old. There are sleeve bearing cranes and roller bearing cranes; traveling cabs and stationery cabs. There are cranes that are used infrequently such as sub-station cranes and others that never stop. It was quite a problem to setup a schedule that would satisfy all cranes. Some cranes required more care because of their age, others because of their usage while some could get by with less attention.

Each crane was given a separate consideration. The schedule established a fixed time of the day and a fixed number of minutes per crane. The time varied from 30 to 60 min per crane, and from once a day for some to once a week for others. The operating people knew precisely when a crane was scheduled to go down and made all the necessary arrangements to release the crane without interference to production. Enough maintenance personnel were assigned the task to be on the crane the minute it was released to inspect, lubricate and repair. This was a lot better than having the crane out of service unexpectedly at a critical time or when they seemed to need it the most. Major repairs or repairs that took longer than the alloted time were scheduled for a more appropriate time.

Crane breakdowns are now at an all time low and our production records have all been broken within the past year. Of course the cranes are not solely responsible for these production records but they surely help to make or break them. The crane maintenance department has an unblemished safety record that goes back to December of 1950. That is almost 9 years (1,325,000) manhours without a lost-time accident in a department that works under many hazardous conditions. This is something we are proud of and we hope the safety record will continue.

This schedule has made it possible to apply what we consider to be a sound maintenance procedure.

1. Sufficient lubrication properly applied.
2. Inspection that enables us to be continually aware of the condition of equipment.
3. This inspection puts us on the alert to have adequate spares available in anticipation of repairs.
4. The schedule assists us to carefully plan men and materials to most effectively complete repairs.
5. It provides a means to record what, how and when repairs are made.
6. By these established records, it enables us to anticipate maintenance requirements, in the form of manpower, spare parts, working tools and equipment.

All agree that sound maintenance is a good thing when properly performed. Just as production requires schedules, so does maintenance. The active co-operation of operating and maintenance personnel plus the blessing of top management is required to make any maintenance program a success and this is what we are striving for at the Ford Motor Co.'s steel division.

"RESULTS OF PLANNED MAINTENANCE REPAIRS"

by R. R. KENNY
Assistant Manager Maintenance
Steel Div., Ford Motor Co.,
Dearborn, Mich.

FORD is well aware of the many benefits derived from an effective planned maintenance program. To assist in implementing the Ford planned maintenance program, we have adopted the following slogan, "If you never run out you have too much." This slogan was not original but was borrowed from our general manager during his relentless drive for lower maintenance costs and lower inventory levels.

In order to operate within the confines of a slogan such as this, we were compelled to search for new materials, develop new methods and procedures in furnace rebuilds. By so doing, it was possible to improve departmental efficiency, increase furnace availability, reduce refractory inventory by better than fifty per cent. Also rebuild time has been reduced by hours, and in some instances, days.

In the soaking pit area, with the use of a castable refractory and metal forms fabricated in the shops, we now cast the burner block, peep sight and coping tiles as needed or prior to installation. This method and procedure has eliminated the large stockpiles of special refractory shapes.

In January, 1958, a castable soaking pit cover was put into service. For the placement of this castable, a refractory gun was used. The total time required to gun this cover was 18 manhours. Comparing this to the 96 manhours required to build a brick cover, finds a savings of 78 manhours. This cover remained in service for a period of 10 months before a small patch was required at the front or skew line area. This is where the cover developed its first failure—the repair was made and the cover was put back in service. There is now 22 months service on the cover with one repair.

In March, 1959, the first, plastic soaking pit cover was completed. The cover is placed on its side to permit ease of ramming. This cover is approximately 100 ft wide and 27 ft long. Plastic is rammed to a thickness of nine in., anchor tiles were set at one-foot centers, and several to the cover by a three-inch I-beam.

This being our first cover, it is felt the seventy manhours for installation were excessive. We now have eight months continuous service on this cover and just last week the second plastic soaking pit cover was put into service.

One unusual condition at our plant, was the failure of a soaking pit exhaust port arch. When this happens, one not only stands the chance of losing an entire burner wall, but also a costly pit shutdown, and substantial loss of production during the repair.

To overcome this situation we turned to a flat suspended arch and tunnel roof. A 14-in. I-beam is used to suspend our arch or bullnose. Directly above these are two 4 x 6-in. angles which assist in supporting the burner wall. Additional steelwork was designed to carry our roof.

This installation is now complete. Note the three-inch setback (Figure 1) on the arch or bullnose—this setback was cut in to protect our arch from mechanical abuse.

Because this is a very recent installation, we are unable to give a service life at this time.

On any complete pit rebuild, the removal of rubble and slag from tunnel or collector flues presents a problem. Normally, because of heat, this operation cannot be started for at least 16 to 32 hours. Now, four hours after the pit is off the line, one man and a hi-low fitted with our hydraulically actuated boom can remove brick slag and rubble from the flue. A task that normally requires 25 to 30 laborers is now being accomplished with three men.

In the annealing section, there is one single-stand furnace that operates with a multiple three-base setup. These bases were originally lined with 2300 F insulating firebrick. The manhours to lay up this base, cut and form the firing track and brick in the 24 burners would be approximately 80 manhours. To increase the furnace availability, we designed a three-section metal form conforming to the inside diameter of the refractory lining and the firing track. With this form and a light weight castable, it is now possible to install a monolithic lining complete with firing track and burner opening with 24 manhours.

Figure 3 shows one triple-fired continuous slab reheat furnace. There are three furnaces such as this at the 66-in. hot strip mill. These furnaces are approximately 80 ft long and 20 ft wide. Temperatures within these furnaces, when fired with oil or gas, range from 2350 to 2450 F. The slabs enter into the primary zone, onto the heating zone and then to the soaking zone where they become the same temperature throughout. To handle the problem of expanding refractory inventories, we turned to plastic. It is interesting to note that this entire construction can be accomplished with plastic and only one brick shape in inventory. The refractoriness and spall resistance of plastic accounts for the increased life of walls and roofs in these furnaces, as compared to their life when built with brick shapes. The plastic monolithic construction, with its elimination of joints, reduces fuel consumption and increases furnace output.

Figure 1 — A 3-in. setback is used on the bullnose to protect it from mechanical abuse during pit operation.

The millwrights and carpenters set the prefabricated forms in place to form the front face of the low-zone burner wall. The sub-hearth is bricked up, the hard skid rails and the 4½ in. water skid rail are set in place. The burner opening forms are set. The void between the burner openings or the space between these wooden forms is filled with a castable refractory material. We also attach anchor tile to assist in holding castable to the shell of the furnace. We brick the sub-hearth up to approximately 7 in. below the top of the hard skid rails. Onto this we will gun our hearth in place. The castable on the hearth is held to 1 in. below the top of the hard skid rail and controlled to a 2½ in. contour in the center. This is done to permit the heaters and the furnace operators to remove the slag from the hearth.

The castable is brought up to 1 in. below the top of the skid rail and held to a 2½ in. contour. You will note the primary objective was not to see how fast we could install our hearth and burner wall, but rather the primary objective was to locate a refractory that the scale and slag would not adhere to during the furnace campaign. In previous installations it was frequently necessary to go in the furnace with busters and laborers and remove the slag and scale. Now the slag and scale is removed with an ordinary board and shovel. It is not necessary to use hammers and the laborers. In using hammers and laborers, it was necessary then to come in with bricklayers and rebrick a portion of this hearth and place a refractory material back on the brick.

Next, we move to the outer shell of the slab reheat furnace. The millwrights and welders weld alloy couplings on approximately 24-in. centers or however the steelwork will permit. We absolutely did not alter the steelwork in this furnace in any way for the plastic firebrick installation. The plastic is rammed to approximately 10 in. above the skid rail before the first row of anchor tile is tamped in place. Special care is taken not to crack this anchor tile, but we merely want to tamp it and imbed it firmly into the plastic. We make certain that the plastic is tamped around and behind the anchor tile and up against the 2½ in. block of insulation. This is done to protect the alloy fastener and the small alloy coupling that has been welded to the shell of the furnace. Additional plastic is then placed on the wall and the same process is continued throughout the entire wall. Notice the ease in which this hammer is handled. He does not force or press it into the plastic. He is merely guiding it back and forth to form the plastic in place. We determined this wall should be a 15-in. wall with 2½-in. block of insulation making a refractory wall of 17½ in. The previous wall made of brick was 22½ in.

The plastic comes to our plant with moisture added by the manufacturer and wrapped in moisture-proof paper, placed in cardboard boxes and shipped on pallets. It is very easy for two or three laborers to keep 10 or 12 bricklayers busy on a wall at all times. We have eliminated the use of fireclay, mixing and mud pans. The plastic is brought to a furnace on pallets, unwrapped and rammed on the wall. We form up over inspection doors. We have eliminated the arch brick, the special shapes and the cutting and fitting of brick.

Prior to light-up, the wall has been faced and vented by merely sticking welding rod into the wall. Here are

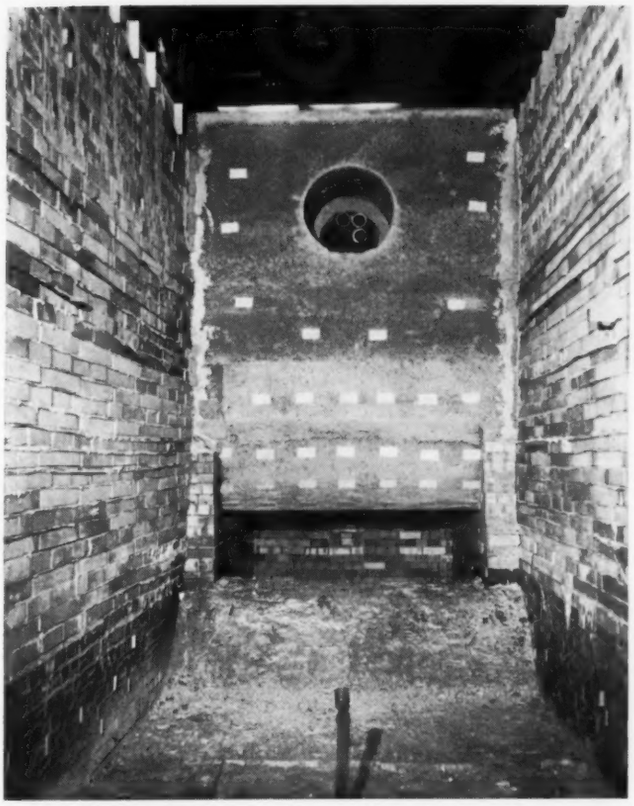


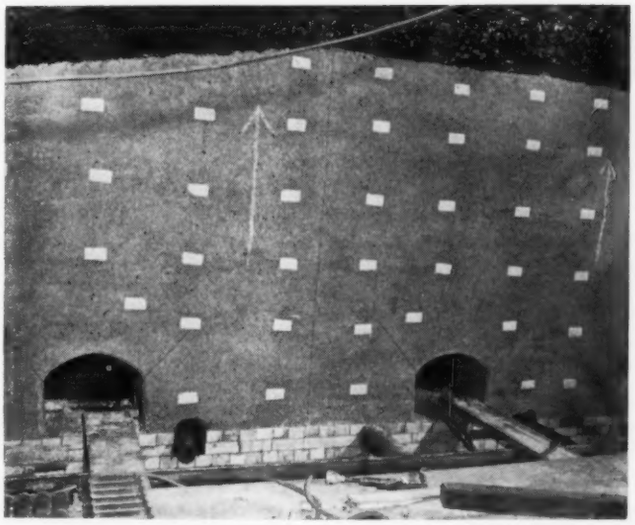
Figure 2 — The plastic burner wall and exhaust port were installed in October, 1959.

the inspection doors. We control expansion by merely cutting with a shovel a 45-degree expansion joint approximately 1½ in. deep and 18 in. long.

This wall today looks every bit as good as the day it was put into service. There is absolutely no spalling or breaking off of refractory throughout the entire wall. There is only one anchor tile which shows any indication of breaking down. Some installers of plastic feel that the way to control the expansion is to let the wall crack and the irregular edge of the crack will tend to assist in holding the wall together.

Expensive cutting and fitting of brickwork is postponed. The bricklayer will probably place a brick two

Figure 3 — Plastic mixes were used on the triple-fired, continuous slab reheat furnace. No repairs were needed up to date of presentation. Installation was made in December, 1957.



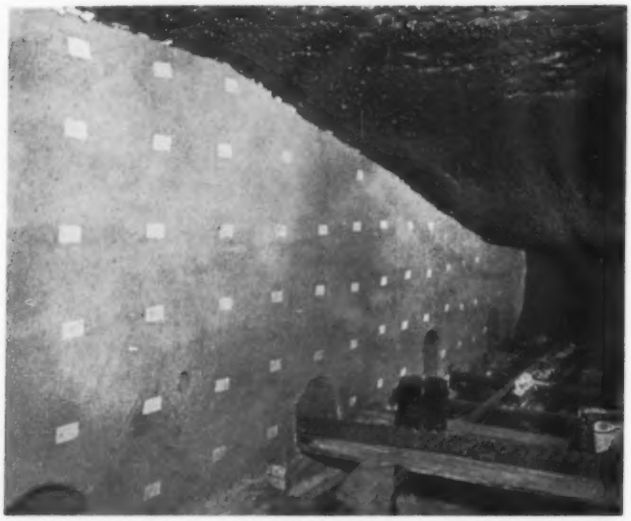


Figure 4 — Plastic side walls in Zone No. 2 of slab heating furnace.

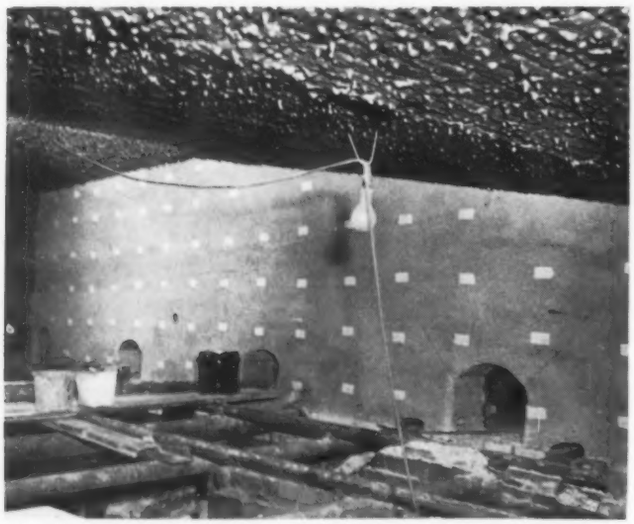


Figure 5 — Plastic side walls in No. 3 reheat furnace have given good service.

or three times before he is satisfied it will fit. There have been instances when we removed a complete bullnose and started all over again. A bullnose uses approximately 3000 bricks at 93 cents a piece and 500 metal fasteners at $1.25. This is the only place in the entire division where we can use this brick and we are required because of safety measures and operating conditions to keep a complete bullnose in inventory at all times.

In our merchant mill reheating furnaces these same economies are being effected with plastic as on the hot strip mill. The burner wall is approximately 5½ ft high and 30 ft long. We are using a ½-in. asbestos board between the plastic and the steel shell of the furnace. There are two rows of anchor tile in place approximately 18 to 24-in. centers. This wall has 15 burner openings and slots alongside every other burner, which are used by the heaters in adjusting the billets. It is our contention that it would be an impossibility to work enough bricklayers on this burner wall to brick up and level up over the 15 burners in any one 8-hr day. The time required to install this plastic burner wall is 5½ hr. Approximately 65 to 70 manhours were required to ram this wall and there are savings of 150 to 175 manhours.

These few installations have assisted in improving departmental efficiency, the reduction of material inventory accounts and also given a substantial reduction in furnace rebuild cost.

Discussion

PRESENTED BY

WILLIAM SCHARFENAKER, Chief Ceramic Engineer, National Steel Corp., Ecorse, Detroit, Mich.

R. R. KENNY, Assistant Manager Maintenance, Steel Div., Ford Motor Co., Dearborn, Mich.

William Scharfenaker: On high-lo, are the tools on it standard accessories?

R. R. Kenny: We built it in our industrial truck repair shop.

William Scharfenaker: It looks like a versatile unit. Can you use it for applications other than the one you showed?

R. R. Kenny: We constructed it in three days.

William Scharfenaker: How long have you had it?

R. R. Kenny: Two weeks. We took it out in the yard to see if it would dig a ditch. We dug the ditch.

William Scharfenaker: You have not had time to find out what you can do with it?

R. R. Kenny: If it does not work any place else, it sure paid for itself in the tunnel.

"SPECIALIZED MAINTENANCE FOR MODERN SINTER PLANTS"

by J. BARANYI
Assistant Superintendent Primary Mechanical
Great Lakes Steel Corp.,
Div. of National Steel Corp.,
Ecorse, Detroit, Mich.

ONE can pick up almost any trade magazine and find at least one article devoted to the much discussed subject of preventive maintenance. There have been many prerequisites of good preventive maintenance programs established, all resulting from sound theory and practice. Some of the prerequisites of a good preventive maintenance program are:

1. Establish a good maintenance organization.
2. Provide adequate manpower.
3. Preplan all activities.
4. Maintain good communications.
5. Have the approval and backing from top management.
6. Co-ordinate activities with operations.
7. Establish a system of inspections.
8. Build flexibility into the plan.
9. Accumulate and use historical data.
10. Maintain a good spares inventory.
11. Utilize downturns for repairs, lubrication, etc., where it will not interrupt operations.

12. A host of other prerequisites are necessary for good preventive maintenance.

It has been proved many times, by many industries, that a properly organized preventive maintenance program is a very sound investment, that has increased many a profit picture. They have reduced unscheduled machine downtime, as a result production volume increased. They reduced wasted man power because the jobs were preplanned. Good lubrication practices lengthened the life of many pieces of equipment. Goodwill and co-operation between operating and maintenance departments have been strengthened. Morale of employees reach new highs because of the lessened confusion and proved results. It can be said then, that a properly organized preventive maintenance program is essential to any industry.

A good program does not just happen. It must be developed or engineered by qualified personnel who know what they want to accomplish. A thorough investigation of the plant must be made. From the results of this investigation, plans should be formulated to incorporate those good practices now in effect in your plant, with the prerequisites of good preventive maintenance, which will give the greatest benefits to your particular plant.

When we arrive at the decision as to which type of program will give the most effective preventive maintenance program, we have reached what is termed "specialized maintenance." As stated previously, the system which is setup for a particular plant must be designed to fit the needs of the plant in order to establish the most effective preventive maintenance program.

A program of planned preventive maintenance cannot be carried out successfully by the maintenance department alone. It requires the complete co-operation of the operating and maintenance departments, and has to have top level interest and backing. It also has to utilize the staff services available. The effect of good relations and co-operation on any organization is far reaching. Good relations and co-operation have a direct bearing on morale in both operating and maintenance departments, on their ability to meet production schedules, through having a well maintained plant and on their ability to carry out maintenance plans successfully from start to finish of each repair job.

A stiff selling program must be accomplished also. There are too many maintenance and operating supervisors who share a common feeling that it is impossible to plan work in advance, arguing that breakdowns, rush jobs or uncompleted work lists would interfere or prevent any sort of plan or schedule from being carried out, and that if such plans or schedules were formulated, they would be just wasting time with paperwork. This type of thinking indicates several things. First, it is a good indication that they have no planning program at all, or if they do have one it is ineffective. Also, their planning or scheduling lacks the flexibility that is necessary for good planning.

At the Great Lakes Steel Corp., is one of the largest and most modern sinter plants in the world. This plant was placed in operation August 13, 1958, with a daily rated capacity of 7000 net tons of sinter product. The plant consists of 88 belt conveyors, which were grouped into nine systems. The sinter plant proper contains a 12-ft sinter machine with such prominent features in the sinter mix system as a drum type pug mill 11 ft in diam by 14 ft long, and rotates at 8 rpm. The pug mill contained a counter rotating paddle shaft assembly 36 in. in diam rotating at 66 rpm. Another feature is a balling drum 12 ft in diam and 50 ft long, rotating at 9 rpm on a slope of 1⅛ in. per ft. Water is added to the sinter mix inside the balling drum by means of sprays. Another feature is two ignition furnaces. The original furnace measures 12 ft-3 in. wide by 11 ft long inside, has 10 burners, four burners on each side for firing horizontally and two burners on the upstream wall firing downward toward the edges of the sinter bed. The furnace has a flat suspended roof. The wall brickwork is supported by water-cooled boxes. The second ignition furnace which was recently installed contains 30 burner nozzles in the roof which provide indirect firing.

Still another feature is the sinter breaker, consisting of 11 four-pronged wheels 5 ft in diam, mounted on a water-cooled shaft and driven by a variable speed motor. Each prong has a removable hard surface tip. The breaker rotates between fixed capped breaker bars. The breaker rotates at 5 rpm. Another feature is the two rod mills 8 ft-6 in. in diam by 12 ft long, with a 30,-000-lb rod charge. These rod mills grind coke breeze necessary for the sinter mix.

Because of the size and the complexity of the No. 2 sinter plant in general and the many special features of this plant, it was necessary to thoroughly study the plant in order to setup an effective maintenance program designed to fit the needs of this modern plant, utilizing in this maintenance program the prerequisites necessary for successful maintenance planning.

Because of the newness of the plant, no historical data was available, consequently sound judgment had to be used in estimating the manpower requirements that would be adequate to carry out a planned program. Also, since most of the maintenance forces were new to this type of operation, they were given an opportunity to familiarize themselves at a time when reduced operations were in effect. Approximately December 1, 1959, production requirements dictated that the sinter plant be placed on a twenty-turn operation. The twenty-first turn was to be used as a scheduled downturn for planned maintenance of equipment in the sinter plant proper. During the period of lesser operation, it was noted that operating schedules could be arranged, so that each day, part of the facilities outside the sinter plant proper could be scheduled down for repairs, provided, that certain preplanned activities were performed. For example, Tuesday, P4, F2A, F3S, P6 conveyors could be shutdown for repairs from 7:30 am to 3:00 pm. The provision being that all bins at "D" furnace should be full at 7:30 am on this day. This now gave us the program for shutting down a definite portion of the plant each day for pre-planned maintenance.

During the week, inspections are made by operating and maintenance personnel, and the results of these inspections are discussed at a preliminary meeting of operating and maintenance personnel, which is held on Friday afternoon. At this meeting, these lists of work are reviewed, priority ratings and preferences are made known, and the results of the previous weeks work schedules are reviewed. The maintenance general foreman then proceeds to group the jobs to be done into areas, and assigns these jobs to supervisors responsible

for that area. The maintenance general foreman and foremen then estimate the manpower requirements, and time required for each job.

At a second meeting held on Monday morning, these plans for the coming week and completed work schedules of the previous week are reviewed by operations, maintenance and representatives of top management. There are various staff and service representatives at this meeting also. Any corrections, additions, or deletions are made at this time, and the new schedule is finalized and approved. At this meeting, new ideas, future plans and other items of importance are made known and discussed.

These meetings stimulate co-operation between operating, maintenance, service and staff supervision and the presence of top level management indicates the interest and importance of such a maintenance program.

After this meeting, the general foreman distributes the approved work schedules to the supervisors, who immediately make the necessary preparations for manpower, material, tools and equipment. They communicate with operators, shops, staff and service personnel to insure complete co-ordination. These jobs can now proceed "as planned."

In a plant that has within its confines 88 belt conveyors, special attention had to be given to the matter of belt repairs. Since a great number of our employees were not familiar with belt repair work, a training program had to be setup to familiarize the employees with belt repairs. This is a slow process, at best, and with the large turnover in the maintenance forces, it is necessary to train employees in belt repair work almost constantly. Classes were held in the sinter plant repair shop to familiarize employees with various aspects of belt repair. The instructors were trained personnel from conveyor belt supply companies. A steady improvement is expected in this area.

Lubrication is also a prerequisite of good preventive maintenance. We have established a lubrication schedule which indicates what is to be lubricated, what lubricants to be used, the frequency of lubrication and requires the initials of the individual who performed the lubricating task. Samples are taken of the lubricants used in the various gear reducers and analyzed to determine when the lubricant should be changed, and the solids in the lubricant also indicates wear rates.

Each maintenance supervisor is required to log his daily activities. This log proves invaluable, because it shows daily distribution of man power, time required for each job, materials used, difficulties encountered, inspection notes, etc.

With this type of planning, one gets the little jobs done as well as the big ones. One reduces interruptions to jobs because of poor planning. The maintenance man develops more pride in his workmanship by seeing one job completely finished without interruption and then moving on to the next. With this type of planning, supervisors will find planning and scheduling one of his most important and valuable tools. The importance of co-operation must be emphasized and can be strengthened by regularly scheduled meetings to jointly plan the maintenance program. The importance of meetings cannot be minimized or eliminated as they are the basis upon which sound programming for repairs should be established.

"SERVICE AND MAINTENANCE FOR CONTINUOUS HOT & COLD PICKLE & ANNEALING LINES"

by A. A. DeBLANDER
Superintendent of Operations, Stainless Steel Div.,
Jones & Laughlin Steel Corp.,
Louisville, Ohio

THIS paper emphasizes the importance of preventive maintenance as it is related to operating efficiency, cost control, quality control and product yield. Efficiency and cost control of operations has a similar effect on maintenance.

OLD PRACTICE

All of these comments will be concerned with the continuous annealing and pickling of stainless strip and sheet, however, some may well be included in the processing of other types of steel.

Many years ago, annealing and pickling of stainless strip and sheet was performed in two separate operations. The annealing speeds were determined by the time required at certain temperatures to obtain the necessary physical properties of the product and the rate of travel through the pickling tanks were adjusted to any degree that would produce a clean, uniform, unetched surface.

Today, however, the two operations are combined and there can be only one speed for a given product which is based on the annealing practice. This may be 10 or 100 fpm and the pickling equipment and procedures must perform satisfactorily at both extremes or anywhere in between.

NEW UNITS

In building a new unit, the various types of product, size ranges and operating practices are predetermined and it must be assumed that the design and installation will meet their obligations. After that, desired performance will be entirely dependent on proper maintenance. Operating crews are not immune from responsibility, however, this only exists when the unit is electrically and mechanically functioning properly.

CONDITIONS

In spite of the extreme precautions that are exercised in controlling atmospheric conditions within the area of these operations, the units are always susceptible to acid fumes, moisture, dust, humidity and, depending on the location of these units within the plant, even the weather can have serious effects on these conditions.

Therefore, due to these unfavorable conditions, and the absolute necessity of an uninterrupted, continuous operation, these areas will command more than normal preventive maintenance, and *special* attention must be given to lubrication, electrical contacts and fine tuned instruments.

LINE AT LOUISVILLE

At Louisville, one of the lines processes stainless strip and sheet measuring from 0.020 to $\frac{3}{16}$ in. thick in a width range from 18 to 50 in. at speeds from 10 to 125

fpm and, sometimes the product mix demands as many as six to eight changes in size and speeds within these ranges in an 8-hr turn. One can then appreciate the importance of maintenance control that is necessary to accommodate these variables.

In order to stress the importance of preventing line stoppages, it should be mentioned, that there are three pickling tanks, each 50 ft long and the equalizing and preheating furnaces are a combined 85 ft in length so that we could spoil 235 ft of steel at an average of $1.00 per foot.

The fact that these frequent changes in product sizes and speeds must be made without delaying the operation, means that we are entirely dependent on the efficiency of all components of the line. Some of the features of the lines that are affected by these variables are: Wringer rolls may be performing satisfactorily on narrow widths and slow speeds but the amount of carry-out of the acid baths or of spray water into the acid tanks, causing neutralization, could be ten times greater at higher speeds and wider widths.

BACK TENSION

Proper back tension will vary with strip size due to it's weight and with speeds because of the momentum and guiding methods.

If back tension is excessive, this could raise the strip above proper furnace catenary, stretch the strip in the furnace, over-tax the necks and bearings on deflector and sinker rolls, create slippage in the pinch or bridle rolls that pull the line, or exceed the power limitations that would cause the line to kick out which, in some cases, could cause the strip to become burned in the furnace or over-etched in the pickling tanks.

A lack of sufficient back tension would permit the strip to fall below the desired furnace catenary, drag the floor of the pickling tanks, fail to provide enough traction on the free running rolls creating slippage that would scratch the strip and the rolls, and, would produce a loosely wound coil at the delivery end.

GUIDING

Since line speeds increase in relation to the decrease in thickness and the difficulties in guiding become greater when processing thin strip and higher speeds, it is easily recognized that guiding facilities must be properly maintained at all times in order to meet these variables.

SHOTBLAST EQUIPMENT

There are some anneal and pickling lines that include shot blasting equipment and this is used, almost exclusively, when processing hot rolled material.

Due to the erosion that takes place within this equipment, it becomes necessary to inspect its interior, once every eight hours of operation, for worn wear plates and rubber curtains that protect the outer shell and to examine the paddles on the shot impellers. When this is done during operations, it is necessary to stop the line, and the planning of methods and manpower for this inspection should be such that a minimum of time be required to prevent damage to the material being processed. Under normal conditions, this should not exceed six or seven minutes.

At times, it is necessary to make corrections immediately, but usually, records are kept so that these can be made during the next inspection or when the line is not operating.

TANK INSPECTION

In processing different types of stainless steel and the various pickle finishes required it becomes necessary to change acid baths at intervals that should provide sufficient opportuuities to inspect the tank lining and rubber covered sinker rolls for damage or wear. This is important and, if overlooked, the steel casing of the tank or drum of the roll will be exposed to acid corrosion.

Moreover, the exterior of pickling tanks should be examined every 24 hr for possible leaks and, in this manner, repairs can be made before becoming serious.

ROLL BOLTS

A daily inspection for loose bolts in the pillow blocks of all rolls is mandatory. One single roll that is out of alinement can create havoc in proper tracking of the strip, since most of today's lines are over 500 ft in length having 50 or more rolls each with four bolts.

WELDING

Due to the high temperatures that are employed in annealing stainless strip, we find it necessary to join coils by welding rather than riveting. There are several methods of welding and most popular of these are:

1. Lap welding by the spot method.
2. Butt welding by fusing the coil ends together with the use of a tungsten electrode.
3. Butt welding the ends with molten filler wire.

Here again the success of the operation isdependent on the ability to control variables. Different thicknesses of the strip and different grades of stainless steel will require, various changes in the speed of torch travel, the dwell time of spot electrodes, changes in current, the rate of feed of the filler wire and the gap width between coil ends.

BURNERS AND INSTRUMENTS

Continuous annealing furnaces are most always divided into three zones. Cold steel is always entering the first zone and the demand on these burners is quite extensive. The burners in the middle zone need not work as hard and those firing zone no. 3 are mostly coasting.

For these reasons, greater attention must be given to burners in a continuous furnace than those of other types and the best methods to follow would be those that are given in the manuals which are usually furnished by the manufacturers. This is also true of furnace instruments.

CONTROL CABINETS

Continuous lines require a multitude of electrical devices and many of these are temperature sensitive. Therefore, the control cabinets should be located where they are not affected by the heat of the operations and, if this is not possible, auxiliary methods of temperature control must be employed within the cabinets. ▲

PROGRAM

1960 AISE CONVENTION and IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

Tuesday, September 27

9:00 am—REGISTRATION—Main Lobby

9:15 am—BUSINESS MEETING—Ballroom

Conducted by President S. C. Read

9:30 am—COMBUSTION SESSION—Ballroom

Chairmen: Edward W. Fitch, Chief Combustion Engineer, Republic Steel Corp., Youngstown, Ohio.
Stephen Vajda, Process Development Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Techniques in Rebuilding Open Hearth Furnaces" by Carl F. Bessent, Supervisor of Maintenance, Mechanical Maintenance Dept., Bethlehem Steel Co., Sparrows Point, Md.

"Evaluation of Checker Design" by F. D. Nelson, Assistant to Manager, Steel Production, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"A Comprehensive Method for the Thermal Design of Regenerators" by J. W. Hlinka, Senior Research Engineer, F. Puhr, Research Engineer, and Dr. V. Paschkis, Professor, Mechanical Engineering and Director, Heat & Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y.

9:30 am—LUBRICATION SESSION—Club Room B

Chairmen: Norman A. Bracht, General Foreman Roll Shop, Alan Wood Steel Co., Conshohocken, Pa.
Robert L. Humphreys, Assistant Master Mechanic, Bethlehem Steel Co., Sparrows Point, Md.

"Test Stand Evaluation of Oil Film Roll Neck Bearings" by Norman A. Wilson, Manager of Research, and Samuel S. Rickley, Chief Engineer, Morgoil Bearing Dept., Morgan Construction Co., Worcester, Mass.

"Grease on Tap" by Charles A. Bailey, Lubrication Engineer, National Tube Div., and Donald R. McCaa, Product Manager, Standard Products Dept., American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

"Oil Mist Lubrication on Antifriction Backup Roll Bearings" by C. W. Southerington, Chief Engineer, Dallas Div., Revere Copper and Brass, Inc., Chicago, Ill.

2:00 pm—OPERATING PRACTICE SESSION—Ballroom

Chairmen: A. B. Glossbrenner, Superintendent-Conditioning, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio.
John H. Stone, General Superintendent, Flat Roll and Tubular Products, Youngstown Sheet and Tube Co., Youngstown, Ohio.

"New Inspection Techniques and Their Effect on the Mill Operator" by G. P. Michalos, Superintendent of Inspection, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio.

"Analysis of Today's Tube Welding Processes" by Norbert C. Rubin, Vice President, The Yoder Co., Cleveland, Ohio.

"Applying Clear, Mill Type, Pipe Coatings (Methods and Problems)" by Donald A. Golbey, Sales Engineer, The Cleanola Co., Glenshaw, Pa.

2:00 pm—MECHANICAL SESSION—Club Room B

Chairmen: L. S. Mobley, Chief Engineer, Republic Steel Corp., Gadsden, Ala.
Walter Mainwaring, Jr., Works Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"The Heating and Ventilating of a Modern Steel Mill Building" by Charles H. Smith, Consultant and formerly Vice President, L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, N. J.

"Gas Fired, Radiant Comfort Heating" by J. N. Evans, Superintendent, Fuels and Power, and V. J. Urschel, Heating and Ventilating Engineer, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio.

"The Influence of Preloading by Sand Dunes on Economy of Foundations at the New Midwest Steel Mill" by Elio D'Appolonia, President, E. D'Appolonia Associates, Pittsburgh, Pa., and L. A. Fugassi, Chief Engineer, Midwest Steel Corp., Div. of National Steel Corp., Valparaiso, Ind.

Wednesday, September 28

9:00 am—ELECTRICAL SESSION—Club Room B

Chairmen: J. F. Kostelac, Assistant Electrical Superintendent, Midland Works, Crucible Steel Co. of America, Midland, Pa.
Clayton L. Squier, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Lackawanna, N. Y.

"A Training Program for Key Electrical Maintenance Employees" by Dr. Joseph S. Kopas, Training Counselor, Republic Steel Corp., and Director, Human Engineering Institute, Cleveland, Ohio.

"Maintenance of Electric Power Equipment" by John G. Roberts, Power Foreman, Bethlehem Steel Co., Lackawanna, N. Y.

"Safety for Steel Plant Electrical Men" by J. F. Trenner, Assistant Superintendent Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

9:00 am—OPERATING PRACTICE SESSION—Ballroom

Chairmen: W. A. Black, Assistant Director of Research, Republic Steel Corp., Cleveland, Ohio.
R. W. Holman, Division Chief Engineer, Tennessee Coal & Iron Div., United States Steel Corp., Fairfield, Ala.

"Fundamentals of Heat Distribution and Refractory Wear in Electric Steel Furnaces" by W. E. Schwabe, Product and Process Development Laboratory, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

"Production Aspects of the Dwight-Lloyd McWane Ironmaking Process" by H. E. Rowen, Vice President, Dwight-Lloyd, and C. D. Thompson, Assistant to Director of Research, McDowell Co., Inc., Cleveland, Ohio.

"Use of the Open Coil Process to Change Composition and Produce Improved Sheet Steels" by John A. Bauscher, Vice President—Research, Lee Wilson Engineering Co., Inc., Cleveland, Ohio.

2:00 pm—COMBUSTION SESSION—Ballroom

Chairmen: Arthur S. Merrow, Assistant Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.
F. S. Swaney, Chief Combustion Engineer, Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Elimination of a Coke Plant Relief Holder" by H. E. Taylor, Superintendent, Coke & Chemical Div., Alan Wood Steel Co., Conshohocken, Pa.

"Oxygen Steelmaking in the Ajax Furnace at the Appleby-Frodingham Steel Co." by Albert Jackson, Technical Director of Appleby-Frodingham Steel Co., Scunthorpe, and Technical Adviser on Steelmaking, United Steel Companies, Ltd., Sheffield, England.

"Oxy-Fuel Processes Increase Steelmaking Rates" by E. F. Kurzinski, Manager, and R. D. Jones, Development Engineer, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

Exposition and Technical Sessions are at Cleveland Public Auditorium

2:00 pm—ROLLING MILL SESSION—Club Room B

Chairmen: F. G. Kredel, Chairman Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio.
R. C. Schaefer, Assistant Superintendent, Hot Strip, Soaking Pit and Blooming Mill Dept., Steubenville Works, Wheeling Steel Corp., Steubenville, Ohio.

"Analytical Investigation of the Cold Rolling of Bar Stock" by Dr. Alvin S. Weinstein, Assistant Professor of Mechanical Engineering, Dr. Carl F. Zorowski, Assistant Professor of Mechanical Engineering, and Frank J. Loss, Research Assistant, Carnegie Institute of Technology, Pittsburgh, Pa.

"New Automated Structural Rolling Facilities at South Works United States Steel Corp., Chicago, Illinois" by V. H. Lindberg, Superintendent, Structural Div., and J. E. Duffy, Works Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

"Ceco's Ochiltree Works Modern Electric Furnace Bar and Merchant Mill" by W. B. Jacobsen, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and Lawrence S. Barker, Jr., Project Manager, The Rust Engineering Co., Birmingham, Ala.

6:00 pm—OLD TIMERS' DINNER—Euclid Ballroom

Thursday, September 29

9:00 am—ELECTRICAL SESSION—Ballroom

Chairmen: H. W. Dorset, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.
J. A. Bruce Pinney, Assistant Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

"Electrochemistry in the Steel Industry" by E. E. Vonada, Product and Application Specialist, Reliance Electric and Engineering Co., Cleveland, Ohio.

"New Concepts in Power Control Rooms for Steel Mill Drive Systems" by V. E. Verheyden, Design Engineer, Industry Control Dept., General Electric Co., Roanoke, Va., and D. C. Nelson, Plant Electrical Engineer, Jones & Laughlin Steel Corp., Aliquippa, Pa.

"Static Power Supplies for Ore Agglomeration" by M. F. Corcoran, Application Engineer, Industrial Systems Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

9:00 am—COMBUSTION SESSION—Club Room B

Chairmen: William M. Bloom, Senior Fuel Engineer, General Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Charles W. Dunn, Superintendent—Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"5-Zone Reheat Furnace—South Works" by George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

"New Approach to Centralized Utility Dispatching at Fairless Works" by F. W. Allen, General Foreman Utilities Dispatching, and L. Cizmadia, Fuel Engineer, Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Waste Heat Boiler Applications at the Inland Steel Company" by W. M. Douglas, Assistant Superintendent (Power, Steam & Combustion Depts.), Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

2:00 pm—LUBRICATION SESSION—Club Room B

Chairmen: A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.
Robert J. Simes, Superintendent, Mechanical Dept., Lukens Steel Co., Coatesville, Pa.

"A Standardized Method For Rating Roller Bearing Load-Carrying Capacity" by E. C. Denné, Jr., Assistant Chief Engineer, SKF Industries, Inc., Philadelphia, Pa.

"Why Straight Cylindrical Bearings in the Steel Industry?" by Philip H. Hutchinson, Manager, Pittsburgh Zone, Hyatt Bearing Div., General Motors Corp., Pittsburgh, Pa.

"Life Dispersion of Anti-Friction Bearings" by L. E. Root, Senior Engineer, Rollway Bearing Co., Inc., Syracuse, N. Y.

2:00 pm—FOREIGN SESSION—Ballroom

Chairmen: Harry L. Jenter, Vice President—Operations, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio.
Emil Kern, Vice President—Engineering, Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

"Observations of the Steel Industry in India and Japan" by John L. Young, Vice President—Engineering Technology, United States Steel Corp., Pittsburgh, Pa.

"Steel Production in Latin American Countries" by Gen. Edmundo de Macedo Soares e Silva, Managing Director, Companhia Siderurgica Paulista—Cosipa, Sao Paulo, Brazil, and President, Latin American Institute for Iron and Steel, Santiago, Chile.

"Report on the Present Achievements and the Immediate Prospects of Development of Soviet Ferrous Metallurgy" by Ivan Denisenko, Economist, Economic Research Institute, and Roman Belan, Metallurgical Engineer, Head, Iron and Steel Industry Dept., State Planning Commission, USSR.

7:00 pm—FORMAL DINNER AND DANCE—Ballrooms

Speaker: Martin D. Hughes—Noted impersonator and humorist—alias Countess Pulaski.

10:00 pm—DANCE—Ballrooms

AISE members and guests. No admission charge.

Friday, September 30

9:00 am—ELECTRICAL SESSION—Ballroom

Chairmen: John A. Drgon, Division Superintendent, Maintenance and Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.
Thomas Harmon, Chief Electrician, Granite City Steel Co., Granite City, Ill.

"Computers for Industrial Control" by R. W. Sonnenfeldt, Manager, Engineering, Industrial Computer Systems Dept., Radio Corp. of America, Natick, Mass.

"Analog and Digital Techniques Used in Rolling Mill Electrical Systems Design" by D. E. Abell, Supervisory Engineer, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

"Application of Digital Computers for Accounting and Control of Continuous Processing Lines" by R. W. Kirkland, Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

9:00 am—OPERATING PRACTICE SESSION—Club Room B

Chairmen: William O. Bishop, Superintendent, Plant 2 Blast Furnaces, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.
Thomas L. Nabors, Chief Combustion Engineer, Southern District, Republic Steel Corp., Gadsden, Ala.

"Pressure Drop Regulation Closes The Blast Furnace Control Loop" by Otto J. Leone, Consulting Engineer, West Newton, Pa.

"Limitations of Blast Furnace Stoves" by T. R. Schuerger, Supervising Technologist, and Dr. J. C. Agarwal, Research Technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

"The Use of Natural Gas in Blast Furnaces at the Pueblo Plant of the CF&I Corp." by John M. Negomir, Practiceman, Blast Furnace Dept., Pueblo Plant, The Colorado Fuel and Iron Corp., Pueblo, Colo.

2:00 pm—OPERATING PRACTICE SESSION—Ballroom

Chairmen: F. F. Argust, Superintendent, Industrial Engineering, Pueblo Plant; The Colorado Fuel and Iron Corp., Pueblo, Colo.
Clyde A. Roberts, Jr., Chief Engineer, Phoenix Steel Corp., Phoenixville, Pa.

"The Next Step in Steel Plant Data Processing" by W. N. Spray, Manager, Methods & Procedures, Production Planning Div., United States Steel Corp., Pittsburgh, Pa.

"Minimizing Pollution from Pickling Lines: Automatic Control of Strip Pickling Bath Composition" by C. W. Shingledecker, Research Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Steps Toward Coke Plant Automation" by N. F. Agnew, Vice President, Femco, Inc., Irwin, Pa.

. . . . . **Social Functions are at The Statler Hilton** . . .

IRON AND STEEL EXPOSITION HOURS

SEPTEMBER 27—TUESDAY ..... 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 28—WEDNESDAY ..... 10:00 A.M. TO 10:00 P.M.
SEPTEMBER 29—THURSDAY ..... 10:00 A.M. TO 5:00 P.M.
SEPTEMBER 30—FRIDAY ..... 10:00 A.M. TO 4:00 P.M.

IRON AND STEEL EXPOSITION

Exhibit Hall.....Booth Nos. 1-199
North Hall.....Booth Nos. 200-299
Arcade.....Booth Nos. 300-399
Upper Lakeside Hall.....Booth Nos. 400-699
Lower Lakeside Hall.....Booth No. 700

LIST OF EXHIBITORS

A

Acme Steel Co., Fabricated Materials Div. & Acme Steel Products Div.
The Adalet Manufacturing Co.
Ajax Flexible Coupling Co., Inc.
Alemite Div., Stewart-Warner Corp.
Allen-Bradley Co.
The Alliance Machine Co.
The Louis Allis Co.
Allis-Chalmers Manufacturing Co.
American Air Filter Co., Inc.
American Brake Shoe Co.
American Steel & Wire Div., U. S. Steel Corp.
K. W. Atwater Engineering, Inc.
Automatic Transportation Co., Div. of The Yale & Towne Mfg. Co.

B

Bailey Meter Co.
Baldwin-Lima-Hamilton Corp., Industrial Equipment Div.
Bantam Bearings Div., The Torrington Co.
Bearing Service Co.
Birdsboro Corp.
Blaw-Knox Co.
E. W. Bliss Co., Rolling Mill Div., Mackintosh-Hemphill Div. & Combustion Dept.
Bloom Engineering Co., Inc.
C. J. Breitenstein Co.
The Bristol Co.
Buell Engineering Corp.
Burndy Corp.

C

The Cammann Manufacturing Co.
Chalfant Manufacturing Co.
Chemical Construction Corp.
Chilton Co., "The Iron Age"
Chromium Corp. of America
Cities Service Oil Co.
Clark Controller Co.
Cleveland Worm & Gear Co., Div. Eaton Mfg. Co.
Continental Coatings Corp.
Cooper Split Roller Bearing Corp.
Crouse-Hinds Co.
M. E. Cunningham Co.
The Cuno Engineering Corp.
Curry Air Shear Corp.
Cutler-Hammer, Inc.

D

Daystrom Incorporated, Weston Instruments Div.
DeLaval Steam Turbine Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
DEMAG Aktiengesellschaft
Designers for Industry, Inc.
M. H. Detrick Co.
Dodge Manufacturing Corp.
Dravo Corp.
DuBois Engineering & Mfg. Co.
Dynamatic Div., Eaton Mfg. Co.

E

Eaton Manufacturing Co., Cleveland Worm & Gear Div., Farval Div. & Dynamatic Div.
The Electric Furnace Co.
The Electric Materials Co.
The Electric Storage Battery Co., Exide Industrial Div. & Nickel Alkaline Battery Div.
Elliott Co.
The Elwell-Parker Electric Co.
Euclid Electric & Mfg. Co.

F

Fabreeka Products Co.
Farval Div., Eaton Mfg. Co.
Federal-Mogul Service Div., Federal-Mogul-Bower Bearings, Inc.
Federal Pacific Electric Co.
Femco, Inc.
D. B. Flower Mfg. Co.
The Foxboro Co.

G

Gas Machinery Co.
General Dynamics Corp., Liquid Carbonic Div.
General Electric Co.
General Motors Corp., Hyatt Bearings Div.
Gleason Reel Corp.
Golden-Anderson Valve Specialty Co.
Gould-National Batteries, Inc., Industrial Div.
Gould-National Batteries, Inc., Nicad Div.
GPE Controls, Inc.
Gregory Industries, Inc.
Gulf Oil Corp.

H

Hagan Chemicals & Controls, Inc.
Harbison-Walker Refractories Co.
Harmon and Co.,
Harnischfeger Corp.
Brad Harrison Co.
Heil Process Equipment Corp.

LIST OF EXHIBITORS (Continued)

Hewitt-Robins Inc., Jones Machinery Div.
Heyl & Patterson, Inc.
Holophane Co., Inc.
Homestead Valve Manufacturing Co.
Humble Oil & Refining Co.
Hunt Valve Co. (Div. of IBEC)
Hyatt Bearings Div., General Motors Corp.
Hyde Park Foundry & Machine Co.
Hydrocarbon Research, Inc.

I

Ideal Electric & Mfg. Co.
"Industrial Heating"
Industrial Nucleonics Corp.
The International Nickel Co., Inc.
"The Iron Age"
Iron Lung Ventilator Co.
I-T-E Circuit Breaker Co.

J

Jackson Industries Incorporated
Joy Manufacturing Co., Coal Machinery Div.
Joy Manufacturing Co., Electrical Products Div.
Joy Manufacturing Co., Western Precipitation Div.

K

Kane & Roach, Inc.
The M. W. Kellogg Co.
S. P. Kinney Engineers, Inc.
Kolene Corp.
Koppers Co., Inc.

L

LaDeau Manufacturing Co.
Lake Shore Electric Corp.
Larco, Inc.
Leeds & Northrup Co.
LeRoi Div., Westinghouse Air Brake Co.
Linde Co., Div. Union Carbide Corp.
Link-Belt Co.
Liquid Carbonic Div., General Dynamics Corp.
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp.
Loftus Engineering Corp.
Lorica Battery Div., Nife Incorporated
Lundell & Co.

M

Magnaflux Corp.
Manco Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.
Mansaver Industries, Inc.
Markal Co.
Martin Engineering Co.
The Martindale Electric Co.
McDowell Co., Inc. — The Wellman Engineering Co.
McGraw-Edison Co., National Electric Coil Div.
McGraw-Edison Co., Pennsylvania Transformer Div.
Mesta Machine Co.
Mine Safety Appliances Co.
Minneapolis-Honeywell Regulator Co.
Mobil Oil Co., Div. of Socony Mobil Oil Co., Inc.
Morgan Construction Co.
The Morgan Engineering Co.

N

National Carbon Co., Div. Union Carbide Corp.
National Electric Coil Div., McGraw-Edison Co.
Nickel Alkaline Battery Div., Electric Storage Battery Co.
Nife Incorporated, Nickel Cadmium Battery Div.
Nife Incorporated, Lorica Battery Div.
North American Mfg. Co.
Northeast Ohio Machine Builders, Inc.
Nukem Products Corp.

O

The Ohio Bell Telephone Co.
The Ohio Carbon Co.
The Ohio Electric Mfg. Co.
The Ohio Knife Co.
Kurt Orban Co., Inc.

P

Pangborn Corp.
The Pannier Corp.
Pennsylvania Transformer Div., McGraw-Edison Co.
Penton Publishing Co. — "Steel"
Pick Manufacturing Co.
Poole Foundry & Machine Co.
H. K. Porter, Inc.
H. K. Porter Co., Inc., Delta-Star Electric Div.
The Post-Glover Electric Co.
The Pyle-National Co.

R

Radiant Lamp Corp.
Radio Corp. of America
The Ramtite Co.
Ready-Power Co.
Red Seal Electric Co.
Geo. P. Reintjes Co.
Reliance Electric & Engineering Co.
Republic Flow Meters Co.
Research Appliance Co.
Research-Cottrell, Inc.
Ringsdorff Carbon Corp.
Robinson Ventilating Co.
Rockbestos Wire & Cable Co., Div. of Cerro de Pasco Corp.
Rollway Bearing Corp.
Rust-Oleum Corp.

S

Selas Corp. of America
Shell Oil Co.
Silent Hoist & Crane Co.
Simplex Wire & Cable Co.
SKF Industries, Inc.
Socony Mobil Oil Co., Inc., Mobil Oil Co. Div.
Spero Electric Corp.
Spraying Systems Co.
Square D Co.
"Steel" — Penton Publishing Co.
Stewart-Warner Corp., Alemite Div.
Sutton Engineering Co.
Swindell-Dressler Corp.

T

Taylor Instrument Companies
Telechrome Manufacturing Corp.
Texaco, Inc.
The Timken Roller Bearing Co.
The Tool Steel Gear & Pinion Co.
The Torrington Co., Bantam Bearings Div.
Trabon Engineering Corp.
Twin Disc Clutch Co.

U

Union Carbide Corp., National Carbon Co. & Linde Co.
Union Switch & Signal, Div. of Westinghouse Air Brake Co.
United States Department of Commerce
United States Steel Corp.

V

Van Dorn Iron Works Co.

W

Wagner Electric Corp.
Waldron-Hartig Div., Midland-Ross Corp.
The Wellman Engineering Co.
Western Precipitation Div., Joy Manufacturing Co.
Westinghouse Air Brake Co., Union Switch & Signal Div.
Westinghouse Air Brake Co., LeRoi Div.
Westinghouse Electric Corp.
Weston Instruments Div., Daystrom Inc.
Wheelabrator Corp.
Lee Wilson Engineering Co., Inc.
L. J. Wing Mfg. Co.

Y

Yale & Towne Mfg. Co., Yale Materials Handling Div.
Yuba Consolidated Industries, Inc.

Z

Zurn Industries, Inc.

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CLYDE A. ROBERTS, JR.

ABSTRACTS OF TECHNICAL PAPERS

to be presented at technical sessions of

AISE ANNUAL CONVENTION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

September 27, 28, 29, 30, 1960

"TECHNIQUES IN REBUILDING OPEN HEARTH FURNACES"

by CARL F. BESSENT, Supervisor of Maintenance, Mechnical Maintenance Dept., Bethlehem Steel Co., Sparrows Point, Md.

CARL F. BESSENT

△ This paper furnishes a general description of techniques, innovations and methods used in open hearth repairs at the Sparrows Point plant of the Bethlehem Steel Co. All phases of the work are reviewed with special emphasis placed on scaffolding methods and material handling systems. Slides of work-effort on a rebuild are used in the presentation.

Scheduling and planning are necessary for an effective open hearth furnace rebuild program. Complete understanding and cooperation is required between the maintenance and operations departments. Special equipment and material handling methods are utilized to divorce the rebuild from operating equipment.

Fast slag removal is essential to a rapid rebuild. Considerable attention must be given to the drilling and blasting of slag. A track-mounted ram, track-mounted overloaders, a $\frac{3}{4}$-cu yd backhoe and telescopic boom equipment are effective on furnace teardown.

Generally, furnace ends determine the rebuild time. Consequently teardown and bricking procedures take precedent over those of main roof and hearth area and the regenerator system. Demolition scaffolds are installed in the furnace and secured from port roof scaffold beams which also serve for a support to the port roof center. Scaffold beams are installed in the slag pocket for teardown and bricking purposes. Jib booms with air hoists handle pallets for uptake bricking.

Two piece adaptable wooden ribs for the roof center and a stock scaffold on the front buckstays at skew-iron elevation feature the main roof installation.

A simple flue dirt cleaning system has been most efficient. Checker holes are opened by rodding and then mechanically cleaned. Blasting is effective in the removal of entire checker chambers.

Also explained are facts concerned with repairs to furnace structural steel, soot-blower systems, reversing mechanisms and other auxiliaries.

Safety on open hearth rebuild is always given first consideration.

"EVALUATION OF CHECKER DESIGN"

by F. D. NELSON, Assistant to Manager, Steel Production, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

F. D. NELSON

△ THIS paper compares design and operation of furnace checker work installed in 320-ton open hearth furnaces at Inland Steel Co. over a period from September, 1952, through December, 1959.

Initial construction included two furnaces with single-pass checkers and two furnaces with double-pass checkers. The purpose of this design program was to evaluate the two types of regenerators in terms of production, fuel consumption and maintenance costs. Both style chambers were so designed that in the event one system was found to be more efficient, conversion would be possible without any change in existing steelwork or checker binding.

No difficulty was encountered during the early part of the first campaign on the two double-pass checker furnaces, mainly due to the relatively low production

and firing rates. However, as the operators gained furnace experience and as operating refinements were made, it became evident that the two-pass checker design would require higher maintenance.

Through continued experimentation with various refractories, high air and high pressure practice, installation of chimney type flues, establishment of maximum checker temperature and improvement of operating techniques by furnace personnel, the original problems of the two-pass checker system have been solved.

In 1957, three new furnaces were installed with two-pass checkers and have operated well to date. This evaluation of checker design is an illustration of what can be accomplished by utilizing combustion principles along with refractory design changes and operating techniques.

"A COMPREHENSIVE METHOD FOR THE THERMAL DESIGN OF REGENERATORS"

by J. W. HLINKA, Senior Research Engineer, F. PUHR, Research Engineer, and DR. V. PASCHKIS, Professor Mechanical Engineering and Director, Heat & Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y.

J. W. HLINKA

F. PUHR

DR. V. PASCHKIS

Δ TO date the design of open hearth regenerators is based mostly on experience, without benefit of a basic design procedure. In the paper a rational and rigid calculation and design method is presented.

In the first part of the paper a design manual is given in which a detailed calculation procedure is presented. The task of calculation is further simplified by a set of worksheets which are so arranged that they can be used by a technician. Only arithmetic is involved since equations even of moderate complexity are presented in form of graphs.

The use of the manual is illustrated by showing one example in detail.

In the second part of the paper the method is developed. This part includes the discussion of the refrigerator as modified counterflow heat exchanger.

This term defines equipment in which two fluids (air and combustion gases) flow simultaneously in opposite directions, exchanging heat across a dividing surface. In order to apply the heat exchanger equation to regenerator design, two corrections have to be introduced: one to account for the conduction of heat in the flue wall parallel to the direction of fluid flow, and the other for the periodic passage of air and gas through the flue.

The graphs and design procedure permit the determination of air and gas exit temperatures and an estimate of maximum brick temperatures. Inasmuch as the heat transfer coefficients between gas and lining and air and lining are usually controlling the behavior of regenerators, a recommendation is made regarding appropriate selection of data.

A list of possible further work in the field of regenerator design concludes the paper.

"TEST STAND EVALUATION OF OIL FILM ROLL NECK BEARINGS"

by NORMAN A. WILSON, Manager of Research, and SAMUEL S. RICKLEY, Chief Engineer, Morgoil Bearing Dept., Morgan Construction Co., Worcester, Mass.

NORMAN A. WILSON

SAMUEL S. RICKLEY

Δ THIS paper discusses the design and results of three test machines. Two were simple test machines which were used to evaluate a new seal design. They are described and the results reported.

The main portion of the paper deals with the design, instrumentation and preliminary results of a test machine built by the Aluminum Co. of America in conjunction with the author's company.

This machine was designed to test a full size oil-film bearing of the size that would be used, for example, on a small cold mill or a rod mill finishing train. The mounting and loading of the bearing is similar in nature to that encountered in a rolling mill.

The test machine is in operation at the present time testing bearings at speeds up to 1200 rpm and at loads up to 130 per cent of bearing rating. Instrumentation is such that recorded data includes load, speed, oil temperature, oil flow, skin temperature of bushing and torque.

The performance report includes operating performance of different bearing metals and designs, and attempts to compare test results of a rolling mill oil film bearing with some of the theories developed by various engineers and scientists using smaller machines.

"GREASE ON TAP"

by CHARLES A. BAILEY, Lubrication Engineer, National Tube Div., and DONALD R. McCAA, Product Manager, Standard Products Dept., American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

CHARLES A. BAILEY

DONALD R. McCAA

Δ BULK grease handling is the result of improvements in the lubricants, methods of application, and containers made available to steel mills. Now, the industry is ready

to make grease a mill utility item. Methods, practices, and container designs, aimed at the end are presented to show how every mill can have grease on tap.

"OIL MIST LUBRICATION ON ANTIFRICTION BACKUP ROLL BEARINGS"

by C. W. SOUTHERINGTON, Chief Engineer, Dallas Div., Revere Copper and Brass, Inc., Chicago, Ill.

C. W. SOUTHERINGTON

△ FIVE years experience with the installation, maintenance and use of oil mist lubricators on three 4-high mills used for cold rundown and finishing of aluminum is discussed in detail.

The general arrangement section drawing demonstrates bearing arrangement and provisions for use of oil mist passages to effect condensation of the oil, venting of air and maintenance of the oil level. Schematic arrangement of lubricators and piping considerations are discussed as well as protective controls for the system.

The annual consumption of oil on one 35-in. and one 45-in. mill has not exceeded 55 gal between the two mills. The paper discusses experience with regard to oil specifications, maintenance, air requirements, training of personnel, cost of repairs and results of bearing inspections.

Installation of antifriction bearings with oil mist lubrication was first made on a 9½ and 28 × 42-in. aluminum finishing mill which was set up for rolling to 50 per cent commercial tolerance at relatively light gages. On similar mills, there was the problem of gage variation from standstill through the acceleration period, contamination of the rolling coolant oil system with lubricant from the bearing system, contamination of the bearing lubrication with the roll coolant oil, along with space limitations for the installation of equipment for the new mill. The paper discusses considerations which led to use of antifriction bearings with oil mist lubrication and the potential advantages expected to be realized.

"NEW INSPECTION TECHNIQUES AND THEIR EFFECT ON THE MILL OPERATOR"

by G. P. MICHALOS, Superintendent of Inspection, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio

G. P. MICHALOS

△ THE paper presents some of the effects the application of nondestructive test methods in the steel industry have had on mill operating supervision. The objectives and incentives offered the steel industry by the new inspection techniques are outlined, the most important of which is that they afford the industry an opportunity to reduce the present adverse ratio of production to inspection time.

Nondestructive test methods act as an essential guide to the mill operator in telling him how well he is succeeding in his efforts. The reaction or response toward new inspection techniques by the operators will be affected by a number of factors among which are attitude of mind toward inspection in general, and the method by which the nondestructive test methods are selected and applied. Here, the operator can play a big role in the application of nondestructive test methods in his area by a constructive approach and by assisting in establishing realistic methods of application. Those engaged in problems of applying new inspection techniques must be in constant touch with the production effort, and they must be aware of the mill operator's problems and constantly alert to his needs.

The problem of standards, particularly with reference to the inspection of finished product, is discussed. Considerable work needs to be done in this area, and it appears that the solution toward an effective and realistic standardization program must be the result of the accumulated experience of well-informed people of both producer and consumer.

The various areas in which nondestructive test methods are being applied in the industry are outlined, and specific examples, as applied by The Timken Roller Bearing Co. are discussed in detail.

"ANALYSIS OF TODAY'S TUBE WELDING PROCESSES"

by NORBERT C. RUBIN, Vice President, The Yoder Co., Cleveland, Ohio

NORBERT C. RUBIN

△ THIS paper deals with the development of welding processes in the field of metal tube, as opposed to commercial pipe. To differentiate, we consider tube to cover the range of mechanical tubing varying from furniture and bicycle tubing through all the grades of condenser and boiler tubing, and including all products generally called oil country tube, such as casing and drill pipe. This paper does not discuss the processes normally used to produce commercial pipe, generally known as CW or continuous butt weld.

The continuous welding of metal tube began more than 75 years ago. A very early process consisted of oxyacetylene welding but was followed rather quickly by the development of electric resistance welding. Between the years of 1920 and 1950, the development of the electric resistance welding process included the usage of higher frequencies such as 120 up to 360 cycles. This era also brought about the development of direct current welding and there were some installations of arc welding for very slow speed production. In the field of stainless steel tube, we found the advent of atomic hydrogen and, subsequently, helium arc welding.

However, since 1950, the development of tube welding processes has brought about a variety of systems extending into practically all fields of ferrous and nonferrous metals. Basically, the processes available to the tube welding industry today are oxyacetylene welding,

submerged and inert arc welding, a-c resistance welding, d-c resistance welding, 3,000 to 10,000-cycle induction welding, 450,000-cycle resistance welding, and 450,000-cycle induction welding. Each of these processes is still under some stage of development but the important point is that there is a definite application for each of these methods and the question that stands before us is how to select the proper welder for a given tube production.

"APPLYING CLEAR, MILL TYPE, PIPE COATINGS (METHODS AND PROBLEMS)"

by DONALD A. GOLBEY, Sales Engineer, The Cleanola Co., Glenshaw, Pa.

DONALD A. GOLBEY

△ SHORTLY after the turn of the century, it became the practice of many of the pipe and tube mills to coat pipe with an oil to prevent corrosion between the time of manufacture and the time of use. These oils proved to be inadequate and something better was sought.

About 1913 the first clear oxidizing or drying type coating was used. The coatings at first were applied by brush, and later as the demand for it increased, by the flood and wipe method. This method created many problems. Possibly, the greatest number of problems were caused by the collection and recirculation of excess varnish. Oil, water and mill scale became mixed with this recirculated material and actually caused chemical changes in it.

During the 1920's, research into the composition of protective coatings was begun. Increased knowledge brought new resins and an understanding of what was required in the way of equipment to apply them at production speeds. Many novel and partially successful systems were devised.

It was not until 1956, when our company marketed their cone spray pipe coater, that the problems caused by recirculation of oversprayed material and other common problems were overcome. Our engineers, who were familiar with coating problems, began work before this date, however. They set out to design a coating unit that was as free of problems as possible. Reasoning that if spray heads could be designed which were capable of applying 90 to 95 per cent of the sprayed coating to the pipe, the need for direct recirculation would be eliminated.

A spray head unit was designed with synchronously adjustable nozzles. These nozzles produce a fan-shaped spray pattern, the angle of which is changed with changes in pipe size. To further curtail overspray, a means of turning the spray guns, which comprise the spray head unit, on and off as the pipe enters and leaves the field of the nozzles, was incorporated.

Operational data obtained from a pilot model coater showed that by using adjustable nozzles and the precise timing of the spray cycle, the 90 to 95 per cent efficiency was achieved, much higher than could be obtained on most of the older equipment. The increased efficiency cut coating waste and resulted in an appreciable cost reduction.

Other problems not directly connected with recirculation of over-sprayed material were minimized by incorporating in this equipment the high hydraulic pressure system of spraying and by using explosion-proof electric heaters to maintain viscosity control of the coating material.

The equipment, marketed in 1956, has been purchased by many of the nation's largest pipe producers who thoroughly tested it on varying sizes of pipe and at conveyor speeds from 150 to 600 fpm. Their repeat orders confirm the engineering soundness of the cone spray pipe coater.

"THE HEATING AND VENTILATING OF A MODERN STEEL MILL BUILDING"

by CHARLES H. SMITH, Consultant and formerly Vice President, L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, N. J.

CHARLES H. SMITH

△ A MIDWESTERN steel company set two major objectives in design of the heating and ventilating system for its cold strip mill. First was the furnishing of a continuous, positive supply of fresh air throughout the mill buildings, summer and winter. Second was maintenance of comfortable and uniform temperature over the entire floor area, without hot blasts and cold spots. Other considerations were location of heaters and piping to avoid cluttering floor and column areas, and use of a minimum number of individual heating and ventilating units so as to minimize maintenance and inspection.

These objectives were met by the choice of overhead revolving-discharge unit heaters installed in the roof truss area. Two types were installed: recirculating heaters, which withdraw warm air accumulated under the roof, add heat to it and recirculate it to the floor; and fresh air supply heaters, which bring in outside air, heat it, and circulate it to the floor. Special heaters are installed above shipping and receiving doors to temper incoming cold air in winter weather.

Air change of 55,000,000 cu ft once every hour is accomplished by a total of 37 fresh air supply heaters, 25 recirculating heaters, and 15 door heaters, along with 76 gravity roof ventilators, 21 power roof ventilators, and two continuous ridge-type roof ventilators. These serve the plant area which consists of nearly 850,000 sq ft of floor space.

The system is divided into eight independent sections, each of which receives steam at 250 psi and 520 F and reduces it to 100 psi and 400 F before feeding it to the heaters. One recirculating heater on each section operates not on steam but on condensate from the other units of the section. Condensate from one of the eight sections is distributed to all eight reducing stations for use in steam pressure and temperature reduction.

Each heater is operated by its own thermostat station. Recirculating heaters are on, or off, according to floor thermostat demand. Fresh air supply units are

controlled by modulating thermostats which determine how much of the outside air which is continuously flowing through each unit will flow over the unit's heating coils. When floor thermostat demand is high, most or all incoming air is heated. When floor thermostat demand is low, little or no incoming air is heated. Dampers to cut off fresh air intake and to admit air from the truss area are provided, so that in the event of curtailment of steam supply any one or more of the fresh air supply units can be made to function instead as a recirculating heater.

For a representative 15-day period during the recent winter, temperatures were recorded at an exposed building exterior point and at several points within the mill. Outside temperature dropped as low as 15 F during this period, and varied from this low to a high of 45 F. Inside, temperatures did not vary more than a few degrees despite the bringing in and distribution of 55,000,000 cu ft of cold outside air per hour. More important, at no time was there a temperature difference of more than three degrees from one point in the mill to another. Thus no employee moving from one place to another experienced a feeling of chill nor of excessive heat.

"GAS FIRED, RADIANT COMFORT HEATING"

by J. N. EVANS, Superintendent, Fuels and Power, and V. J. URSCHEL, Heating and Ventilating Engineer, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

J. N. EVANS

V. J. URSCHEL

△ LORAIN Works of National Tube Div., United States Steel Corp., has had a most successful winter with their first natural gas-fired infrared radiant heating system.

The building to be heated was an old storage building of uninsulated corrugated steel sheeting construction and with a peaked roof 60 ft high. Heat loss calculations indicated the desirability of insulation for comfort and fuel economy if any of the more conventional types of heating were to be adopted. The estimated cost of insulation alone, however, exceeded the bids on an infrared direct gas fired heating system.

Results during the first year with this novel type of heat were discouraging. Inadequate capacity had been installed, some heaters failed to function properly, and the stack effect of the high building created uncomfortable ground level drafts.

This paper deals with the design of the units themselves, their arrangement for the final successful installation, the troubles of the first year and their correction, and the theories explaining the economies of this intriguing new form of heat as applied to industrial heating.

Other applications of gas fired radiant heating for outdoor spot heating, process heating and area heating within large buildings are also included in this paper.

"THE INFLUENCE OF PRELOADING BY SAND DUNES ON ECONOMY OF FOUNDATIONS AT THE NEW MIDWEST STEEL MILL"

by ELIO D'APPOLONIA, President, E. D'Appolonia Associates, Pittsburgh, Pa., and L. A. FUGASSI, Chief Engineer, Midwest Steel Corp., Div. of National Steel Corp., Valparaiso, Ind.

ELIO D'APPOLONIA

L. A. FUGASSI

△ HIGH sand dunes on the southern shore of Lake Michigan have preloaded an area from the lake shore to approximately one mile inland. The dunes originally present at the plant site were removed by mining years before the acquisition of the property by National Steel Corp. in 1929. Where the dunes have been removed by mining and by shifting during windstorms, the compressed soils that underlaid the vanished dunes have excellent bearing strength and are ideal for spread footings. This is even true where organic deposits lie buried beneath the surface sands. The new Midwest Steel Corp. plant rests on such preloaded sand and old lake sediments.

Initially, an exploratory program was conducted to establish the general nature and strength of the soils. Following preliminary recommendations and parallel with construction, probings were made on a comprehensive scale in the areas of major footings and in the regions of possible buried organic deposits. This type of investigation permitted changes in design with minimum cost and delay. It further assured the safety of the foundations where it had been assumed that the soils had adequate strength. In some areas, buildings are resting as little as ten feet above buried organic deposits. Testing of these deposits showed that they were compressed and are capable of sustaining footing loads with negligible settlement. There was no need to by-pass the organic material with piles or similar type foundations as has been the practice in much of the area.

Studies were made to determine both the amount of settlement and the rate at which it would occur. Observations taken on major foundations and all spread footings support the prediction that settlement of footings resting on the dune-loaded soils would not be a factor. However, spread footings outside the preloaded regions will settle, and could, unless properly designed, lead to difficulties during operation of the plant.

Large savings in foundations were realized by using spread footings. These savings resulted from a complete soil drilling and testing program and by interpreting the soil data in relation to the preloading of the site by the vanished sand dunes.

"A TRAINING PROGRAM FOR KEY ELECTRICAL MAINTENANCE EMPLOYEES"

by DR. JOSEPH S. KOPAS, Training Counselor, Republic Steel Corp., and Director, Human Engineering Institute, Cleveland, Ohio

DR. JOSEPH S. KOPAS

△ RAPID technological progress in industry has resulted in major changes in the performance requirements of jobs. The senior employees who, because of their experience and length of service, are performing the key operating and maintenance jobs in industry are affected most by those changes. Moreover they are in the poorest position to cope with the situation. They need training in applied technology if they are to keep abreast of the technological progress in industry.

However, their limited formal training, age, past experience, traditional attitude toward the value of "theory" versus experience, and the absence of the motivation typical of younger employees interested in advancement and higher earnings presented a unique problem which the existing training programs did not meet effectively.

The management of Republic Steel Corp., recognizing the implications of this problem, decided to develop experimentally a program on a pilot basis in the Cleveland area of its operations. Four years of experimental development and operation of the pilot program produced a program that was regarded as highly successful and effective by company management and employee trainees alike.

Enrollment in the training program is voluntary and the attendance was on the employee's own time. Senior motor inspectors were given the first opportunity to participate. Employee interest was reflected in regular attendance, enthusiastic participation and demand for more courses. Key management employees of the electrical maintenance department were used as instructors and were given special training in the art of teaching. At the present time, a four year program is being made available in four other districts in addition to the Cleveland district.

"MAINTENANCE OF ELECTRIC POWER EQUIPMENT"

by JOHN G. ROBERTS, Power Foreman, Bethlehem Steel Co., Lackawanna, N. Y.

JOHN G. ROBERTS

△ MAINTENANCE of electric power equipment in a completely integrated steel plant involves a wide range of problems including almost every kind of electrical equipment. This paper delves into the problems of a preventive maintenance program for a system with the following specific problems; oil and askarel-filled transformers, motor-generator sets, turbine generators, rectifiers, oil and air circuit breakers, transmission lines at all voltage ranges, and relays.

Discussed in the paper are general considerations that are common to all types of equipment, as well as, specific problems for specific equipment. Under general consideration are included inspection of equipment including the type of personnel and equipment needed for an inspector. Also under general considerations are the methods and necessity of maintaining complete records of the maintenance program, as well as, a spare parts inventory. Safety considerations that are necessary to insure the safety and welfare of all personnel engaged in the maintenance program are also considered.

Under specific problems each type of equipment is considered separately and some of the problems relative to each, like cleaning, insulation tests, oil conditioning, lubrication, spare parts necessary and types and scheduling of service necessary are discussed.

In conclusion this paper discusses some of the problems and methods that are necessary in a power system to insure reliability and continuity of service.

"SAFETY FOR STEEL PLANT ELECTRICAL MEN"

by J. F. TRENNER, Assistant Superintendent Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

J. F. TRENNER

△ SAFETY and electricity are relatively new to industry: electricity had its first practical application in the nineteenth century, safety engineering came into its own in our present twentieth century. The engineering improvements made by the manufacturers of electrical equipment and the continuing efforts of industry to provide safe working conditions for employees are now well recognized.

The safety program now being followed for steel plant electrical men are discussed by the author. Points that receive attention in this paper are: (1) use of the electrical department safety code by all employees; (2) the practice of stand-up safety meetings and their importance; (3) the composition and use of the job safety analysis for recording and recognizing steps to be taken and hazards observed in performing certain jobs; (4) "fresh" monthly material provided for conducting a live safety meeting; (5) training for new hourly employees with emphasis on safety; (6) supervisor training courses; (7) the personal protective equipment program; (8) provision for cause coding of accidents and their analysis to pin-point hazards in certain areas or among groups; (9) the cost of accidents; and (10)the emphasis placed on housekeeping.

"FUNDAMENTALS OF HEAT DISTRIBUTION AND REFRACTORY WEAR IN ELECTRIC STEEL FURNACES"

by W. E. SCHWABE, Product and Process Development Laboratory, National Carbon Co., Division of Union Carbide Corp., Niagara Falls, N. Y.

△ UTILIZATION of refractory is a major economical factor in all melting processes. The service life of a re-

W. E. SCHWABE

fractory depends largely on the temperature attained during the process, and consequently on the heat radiated from the heat source upon the lining.

The paper is concerned with an analysis of the distribution of heat-density on the lining of electric steel furnaces with emphasis on the hot spot problem. A strictly theoretical method is compared with a more realistic analogy model approach. The results of this method point to several possibilities to reduce the heat differential between hot and cold spots by means of positioning electrodes and also by equalizing the power input to the furnace.

"USE OF THE OPEN COIL PROCESS TO CHANGE COMPOSITION AND PRODUCE IMPROVED SHEET STEELS"

by JOHN A. BAUSCHER, Vice President—Research, Lee Wilson Engineering Co., Inc., Cleveland, Ohio

JOHN A. BAUSCHER

△ THE unique feature of the open coil annealing system is the provision of separation or air space between the individual wraps of cold-rolled coils of sheet and tinplate steels. Annealing atmosphere gas is passed through these separations between the wraps of the coil so as to heat and cool the entire coil very rapidly and very uniformly. In contrast, the tightly wound coils used in conventional batch annealing are heated and cooled very slowly because heat can only be transferred to and from the large mass of the coil through its relatively small exterior area.

It was found that excellent drawing-quality steel sheets could be produced with open-coil annealing cycles of only ten hours total time from the start of heating to the completion of cooling. To obtain the same steel properties by conventional batch annealing, annealing cycles as long as a week are required. Also, it was found that all the various tinplate tempers, including the continuously annealed T-U temper, could be produced with open-coil annealing cycles of only about eight hours duration.

Continuing research on open-coil annealing has now revealed that, in addition to conventional annealing, the process can be used to change the composition of steel. That certain gases will react at elevated temperatures with the impurity and alloying elements in steel has long been known, and considerable small-scale laboratory work has been done along this line. As long as 20 years ago, for example, M. Gensamer and J. R. Low were able to remove virtually all the carbon and nitrogen from small samples of sheet steel by annealing them in moist hydrogen. Commercial use of the known gas-metal reactions during annealing has been very limited because suitable large-scale equipment has not been available. In conventional batch annealing, the steel surfaces are not exposed to the annealing atmosphere so the reactions cannot occur. With only a few exceptions (notably the silicon-bearing electrical steels) in continuous annealing, the steel is not exposed to the annealing atmosphere long enough to permit the reactions to proceed beyond the very initial stages.

Neither of these limitations apply to open-coil gas alloying and annealing. All the steel surface can be exposed to the annealing atmosphere for as short or as long a time as is necessary to insure that the gas-metal reactions proceed to the desired end-point. Because of this, the potential uses of gas alloying by open-coil annealing are many, and a whole family of new steel products will undoubtedly result. Sufficient research has already been done to prove that a "direct-on" enameling steel can be produced by open-coil gas alloying. The open-coil annealed "direct-on" enameling steel offers economic advantages to both the steel producer and the enameler. The open-coil gas alloying system can also be used to produce a nonaging rimmed steel, which should be a less-expensive substitute for the aluminum-killed steel presently used in many critical applications. Other research with open-coil gas alloying have indicated that the process can also be used: (1) to improve the magnetic properties and aging characteristics of the plain-carbon and the silicon steels used in motors and other electrical equipment; and (2) to make soft, easily rolled steels harder and stronger by increasing their carbon and/or nitrogen contents during annealing.

"PRODUCTION ASPECTS OF THE DWIGHT-LLOYD McWANE IRONMAKING PROCESS"

by H. E. ROWEN, Vice President, Dwight-Lloyd, and C. D. THOMPSON, Assistant to Director of Research, McDowell Co. Inc., Cleveland, Ohio

H. E. ROWEN

C. D. THOMPSON

△ McWANE Cast Iron Pipe Co. required up to 500 tons per day of pig iron for each of two widely separated foundries. Requirements were not continuous or high enough to justify consideration of the lowest-sized economical blast furnace, and costs of known alternate methods of producing the special iron they required were too high.

A leading research institute was commissioned to make a complete analysis of existing smelting methods and to complete fundamental research studies of each stage of processing from wet ore to hot metal.

A new multi-stage process involving first the application of sintering for maximum economical prereduction, and second, closed top electric furnace smelting techniques was devised. Bench tests of the process were followed by small-scale pilot plant operations during the seven years of the project.

The completed process does not use any types of

equipment or phases of treatment not now in common use in metal-producing plants. A trip through the prototype plant, from the feed of the ores, fuel and fluxes through the stacking of cold pig iron, is conducted by means of colored and black-and-white slides, with a full description of each point of operation.

"ELIMINATION OF A COKE PLANT RELIEF HOLDER"

by H. E. TAYLOR, Superintendent, Coke & Chemical Div., Alan Wood Steel Co., Conshohocken, Pa.

H. E. TAYLOR

△ AFTER forty years service the relief gas holder at Alan Wood Steel Co., upon inspection by a reliable manufacturer, was found to be beyond repair and its replacement was recommended. The coke plant supervision thought that instrumentation (automatic control) might be used to maintain a constant, fixed pressure in the main supplying gas to the rather complex booster system. The latter consisted of motor driven reciprocating compressors delivering 20-psi gas to the steel plant with steam driven centrifugal boosters delivering gas at 4 psi in standby. Preliminary estimates showed that automatic control would cost less than replacing the holder. Furthermore, space for a new holder near the site of the old one was not available. The selection of instrumentation versus holder replacement also avoided a costly plant shutdown. Numerous conferences with manufacturers of automatic controls showed that controls could be installed which would do a satisfactory job. The volume of gas sent to the steel plant by the boosters is controlled by the gas pressure in the booster inlet line. Excess gas to the bleeder, formerly controlled by holder height, is also regulated by an automatic control receiving its impulse by the pressure in this same line. Description of the controls with flow diagram, illustrations of the installation, charts showing operation at essential control points, etc., are contained in this paper.

"OXYGEN STEELMAKING IN THE AJAX FURNACE AT THE APPLEBY-FRODINGHAM STEEL CO."

by ALBERT JACKSON, Technical Director of Appleby-Frodingham Steel Co., Scunthorpe, and Technical Adviser on Steelmaking, United Steel Companies, Ltd., Sheffield, England

ALBERT JACKSON

△ AT the end of 1957 the Appleby-Frodingham Steel Co. completely rebuilt a 300-ton tilting furnace so that practically the whole of the steelmaking operation is accomplished by oxygen lancing. Fuel is only used when charging and fettling and to achieve bath equilibrium, if necessary, when approaching tapping. The reconstruction so altered the furnace design that it cannot revert to its former open hearth steelmaking practice production levels.

The second such furnace was commissioned in June, 1959, and the third in June, 1960. Results are given for the production to date, which is about one million tons. The charge consists of 100 per cent molten iron from an active mixer and contains 1.0 to 1.25 per cent of phosphorus.

Oxygen used per ton is 1270 cu ft and fuel 820,000 Btu. The production increase is 50 per cent above that of a modern all basic furnace prior to conversion, and 100 per cent above that of an old silica furnace in which the "below stage" structure was not of sufficient area to carry the extra fuel firing rate which would have been required to sustain a conversion to an all basic furnace.

Basic refractories are used for the hearth offtakes and slag collecting chambers.

After considerable experimental work involving changes in design, the total consumption of refractory bricks has been reduced well below that of comparable standard open hearth practice.

The furnaces have waste heat boilers and electrostatic gas cleaning plants. They also have two sets of slag chambers and regenerators so that a changeover can be made without taking the furnace off, thus increasing its operational availability.

The thermal utilization overall, when waste heat steam is included, is much higher than the comparable open hearth practice and compares very favorably with most of the installations at present in use operating the modern oxygen blowing processes.

"OXY-FUEL PROCESSES INCREASE STEELMAKING RATES"

by E. F. KURZINSKI, Manager, and R. D. JONES, Development Engineer, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

E. F. KURZINSKI

ROBERT D. JONES

△ OXYGEN is the key reason for the present resurgence in thinking of the open hearth as the primary steel production furnace for the forseeable future. Present oxygen practices, coupled with basic refractories, have made possible increases in steel production rates of up to 40 per cent over prior rates without oxygen or basic bricks. A recent development, the oxy-fuel process, promises to double and even triple the steelmaking rate of open hearths. This accelerated pace of the open hearth will be made possible by the expanded use of oxygen for combustion and for oxidation of metalloids.

Oxygen-fuel practices will minimize the scrap meltdown and the refining periods. During scrap meltdown, oxygen is burned with gaseous fuels to provide a flame temperature approaching 5000 F compared to present end burners operating at about 3500 F. Following hot metal, oxygen is introduced at high flow rates to intensify decarbonization.

The oxygen-fuel mixture is generally introduced by water-cooled lances positioned in the open hearth roof using equipment similar to present oxygen roof lances. This same equipment is then used to introduce oxygen alone. Development work has also been conducted using water-cooled lances located in the furnace end wall. These end jets are designed for those shops having limited overhead clearance.

This paper is a progress report on the results obtained to date in the oxy-fuel process using both roof lances and end lances. This paper will also describe the oxy-fuel equipment used, the problems encountered to date, the aims of co-operative furnace programs presently underway, and the future potential.

"NEW AUTOMATED STRUCTURAL ROLLING FACILITIES AT SOUTH WORKS UNITED STATES STEEL CORP. CHICAGO, ILLINOIS"

by V. H. LINDBERG, Superintendent Structural Div., and J. E. DUFFY, Works Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

V. H. LINDBERG

J. E. DUFFY

△ THE United States Steel Corp. recently installed an automated structural rolling and finishing mill at the South Works Plant, Chicago, Ill. This versatile mill which replaces older mills will add substantially to United States Steel's ability to produce structural steel products, including standard structural shapes, light wide flange sections, sheet piling and semi-finished billets. Light weight wide flange beam capacity will be more than doubled with the addition of this new structural mill.

The purpose of this paper is to review the progress of mill lay-outs, equipment, installation, automatic control features and equipment operation during start-up period from September 28, 1958 to present time. The three principal areas for discussion are:

1. 53-in. primary mill facilities.
2. 34-in. secondary mill facilities.
3. Finishing and handling facilities.

53-in. primary mill facilities—These facilities cover the new U-fired regenerative-type soaking pits, a 53-in. two-high, reversing blooming mill, featuring a card programmed control system which enables complete automatic control of the rolling operation from predetermined schedules as setup on punched cards, a hot scarfer which simultaneously de-surfaces four sides of slabs or blooms, and a down-up cut type electric shear with hydraulic balancing.

The mill produces slabs up to 52 in. wide by 8 in. thick and blooms from 6 x 6 up to 20 x 20-in. square. After the blooms and slabs are sheared, they are removed by cable-drawn transfer cars and piled in a storage yard ahead of the secondary mill facilities, or can be slow cooled for trade shipments and rolling on other South Works finishing mills.

34-in. secondary mill facilities—This area includes two reheating furnaces of 5-zone unique design with capacities up to 150 tons per hour. The furnaces are followed by a 40 in. two high reversing mill, featuring individual motor drives of 4000 hp on each roll (twin drives).

The 34-in. structural mill proper is semi-continuous, arranged in a double hairpin type with two stands in each line. The first and second stands are reversing and the last two are single pass, unidirectional. The setup of the structural mill when rolling CB sections includes numbers 1, 2 and 3 stands as a universal and edging stand combination and number 4 finishing stand, a single universal type. When rolling standard structural shapes, the universal stands are replaced by single horizontal stands and the edging stands are replaced with a movable table section.

Four hot saws are used for parting and cropping product at the cooling bed transfer area. The cooling beds (two), walking beam type, are 140 x 100 ft and 125 x 100 ft.

Finishing and handling facilities—34-in. mill product (beams, channels, angles, sheet piling, etc.), after passing over the cooling beds is processed in either of two continuous processing lines laid out parallel to each other and composed of units of equipment which are identical except in the length of product that can be handled.

Product moves first across cold transfer beds to either of the two roller straighteners, each of which utilizes five top and four bottom rollers of staggered spacing, driven by a 375 hp motor.

From the straighteners, product is moved across inspection beds equipped with turnover devices and from these beds to 700-ton universal cold shears which are used to cut product to the ordered length. Product which cannot be cut by the shears is cut to length by electrically-driven 60-in. friction cold saws mounted adjacent to the shears.

After cutting, product is piled into lifts by 5-ton piling cranes which utilize one of six types (depending on shape handled) of vacuum pads to grip the steel, and is removed from the piling area to storage yard cranes by transfer cars.

Alternate facilities are provided to permit semi-finished product rolled in the 34-in. mill to by-pass the pilers and drop into piling cradles located under storage yard cranes.

Additional interesting features included in this paper are:

1. Automation (card programming) on the 40-in. breakdown mill and on the first two reversing stands of the structural mill.
2. The utilization of step sequencing from the automated stands through the last two structural stands, hot saws and cooling beds, and through the entire finishing lines to the pilers.
3. Bi-level construction of the entire blooming mill and secondary mill facility to provide completely free basement area with good ventilation, freedom of movement, and extensive storage capabilities.
4. Use of mechanical shaker type conveyors for ease in handling mill scale and cinder.

5. Use of fast acting hydraulic lift cylinders for application on bar transfers in the 34-in. mill auxiliaries.

6. Approach to maintenance of automated equipment and related problems.

"ANALYTICAL INVESTIGATION OF THE COLD ROLLING OF BAR STOCK"

by DR. ALVIN S. WEINSTEIN, Assistant Professor Mechanical Engineering, DR. CARL F. ZOROWSKI, Assistant Professor Mechanical Engineering, and FRANK J. LOSS, Research Assistant, Carnegie Institute of Technology, Pittsburgh, Pa.

DR. A. S. WEINSTEIN

DR. C. F. ZOROWSKI

FRANK J. LOSS

△ AN analytic model is investigated for predicting the rolling load, torque and pressure distribution in the contact arc for the cold rolling of bar stock. These predictions account for the lateral spread and elastic entrance constraint and require only information on the mechanical properties of the material being rolled, the geometry of the mill, and the friction characteristics between the stock and the roll. Comparisons are made between experimentally determined load and pressure results and those predicted by the analytical model.

"CECO'S OCHILTREE WORKS MODERN ELECTRIC FURNACE BAR AND MERCHANT MILL"

by W. B. JACOBSEN, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and LAWRENCE S. BARKER, JR., Project Manager, The Rust Engineering Co., Birmingham, Ala.

W. B. JACOBSEN

L. S. BARKER, JR.

△ FOR the past few years Ceco Steel Products Corp. had seen their need growing for a firm source of steel, which source would by necessity be their own production mill. As a result of this, in February, 1958, Ceco contracted for design and construction of a complete new steelmaking facility, to be located near the village of Lemont, Ill.

Basic criteria used to develop production capacity for the new plant was Ceco's steel consumption. The plant was orginally planned to produce 110,000 annual tons of standard size reinforcing bars, angles and merchant shapes. Based on this production requirement, the original plant layout included two, 20-ton per heat capacity, electric-arc furnaces for billet size ingot production, and rolling mill specification was for equipment designed to produce slightly more than basic required tonnage. The rolling mill as actually installed was, however, capable of producing considerably higher tonnage than orginally contemplated; therefore a third 20-ton capacity furnace was added to the melt shop with resultant plant potential at 180,000 annual tons.

Construction began in July, 1958, the first activity being on the melt shop foundations. Melt shop portion of the project was pushed to completion in late March, 1959, with the result that first ingots were cast in early April, 1959. Melt shop operations began on a one-crew, 5-turn per week basis. As furnace operators were trained both furnaces were placed in operation, and the number of turns increased to 20 per week. In March, 1960, the third furnace was placed on the line and currently the entire melt shop is on a 20-turn basis. Even with the relatively green operating crew, the Lemont furnaces are now producing over 12,000 tons per month of billet size ingots.

Rolling mill building construction began in November, 1959; and, despite severe winter weather and late equipment deliveries, the mill was completed and placed in operation by late August, 1960. Rolling mill together with ingot reheating furnace began operations on a 5-turn per week basis. As in the case of the melt shop, additional crews were trained and the mill now operates on a 12 turn per week basis with production well over 1000 tons per month.

The 14-stand rolling mill is fully automated for high tonnage production with a minimum of manpower required. Though the mill is automated, it is also designed to allow quick, economical production changes as required by the rolling schedule.

Transportation-wise, the plant site is ideally located between a main line railroad and the Chicago Sanitary and Ship Canal and further the plant is connected by good roads to a main highway net.

The transition from construction into operation has been smooth and the facility has been operated on a profitable basis since shortly after the first steel was rolled.

"ELECTROCHEMISTRY IN THE STEEL INDUSTRY"

by E. E. VONADA, Product & Application Specialist, Reliance Electric and Engineering Co., Cleveland, Ohio

E. E. VONADA

△ THE subject paper reviews the processes of electrolytic cleaning, electrolytic pickling and electro-deposition (plating) of strip steel. It covers three major areas.

1. The first part of the paper covers very basic theories of electrolytic cleaning and electrolytic deposition. It is the author's feeling that a lack of a good basic knowledge on the part of mechanical and electrical people in both the steel industry and the machinery builder's area are respon-

sible for certain misapplications. While this field is generally understood by the metallurgical departments in the steel companies, the information has not been properly conveyed to the people involved with processing. This section also covers the very critical subject of current densities.

2. With the basic theory in mind, the author then relates this to the specific areas of electrolytic pickling, electrolytic cleaning, electrodeposition, as well as the deoxidation of hot and cold rolled stainless steel by electrolytic pickling. This section deals with the present techniques being used by the industry and a comparison of various systems employed, such as a comparison of the halogen to the ferrostan processes.

3. The third section is the author's personal views from his experience in the industry. It is his feeling that once the basic processes are better understood, that certain of these ideas may stimulate thinking toward new techniques. The author covers other topics as possible causes of corrosion and some potential improvements of electrochemistry in the steel industry.

"NEW CONCEPTS IN POWER CONTROL ROOMS FOR STEEL MILL DRIVE SYSTEMS"

by V. E. VERHEYDEN, Design Engineer, Industry Control Dept., General Electric Co., Roanoke, Va., and D. C. NELSON, Plant Electrical Engineer, Jones & Laughlin Steel Corp., Aliquippa, Pa.

V. E. VERHEYDEN

D. C. NELSON

Δ Today's modern metal rolling processing equipment produces more with greater efficiency than ever before. To accomplish this, the mechanical and electrical equipments have become more complex and require a higher electrical content. Labor costs have risen to the point that the cost of the electrical installation may equal the original cost of the electrical equipment. Realization of this fact opened the door for creative engineering to find ways of reducing the overall installed cost of the electrical equipment.

One solution to this problem is to have the electrical supplier do as much of the over-all electrical work as practical in his factory. After evaluating several concepts, decisions were made and detail design began. Early in 1959, this concept became a reality when the first power-control room was shipped to the Aliquippa Works of Jones & Laughlin.

In general, these power-control rooms included a-c auxiliary control, d-c control, motor-operated rheostats, low voltage control, motor-generator sets and exciters, and ventilating equipment; all being mounted, wired together and completely tested as one integrally coordinated unit. Shipped as complete units, Jones and Laughlin needed only to connect to the a-c supply, make connections to motors and miscellaneous equipment at the line, and wire to the operators' stations.

It is now known that this first attempt did reduce over-all installed cost, and further refinements are expected to make an even greater contribution.

"STATIC POWER SUPPLIES FOR ORE AGGLOMERATION"

by M. F. CORCORAN, Application Engineer, Industrial Systems Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

M. F. CORCORAN

Δ DUE to the fact that direct shipment ores are rapidly becoming depleted and steel production has been steadily rising, quite recently there has been a great deal of activity in the concentration and beneficiation of low-grade iron deposits. This has brought forth the necessity to expand agglomerating facilities to handle this new raw material. Likewise, new systems have been developed which make use of high thermal efficiencies and time-proved equipment.

One of these systems incorporates the use of a grate, kiln and cooler to accomplish the agglomeration. Such a plant is discussed.

As the first application of this process was a scale-up of 120-1 from a pilot plant operation, and because of the many variables which are critical to the proper operation of a plant, it was decided that almost all of the drives which directly handle the green balls, the pellets and their feed systems would be supplied by d-c power and variable voltage control. Rather recently great strides have been made in the development of static power supplies. With a mind toward efficient and maintenance-free requirements, magnetic type amplifier control and power supplies were used to supply all the constant torque applications in this system. The only exception was the kiln drive which because of the regenerative possibilities was supplied with a motor-generator set power supply.

This paper covers a basic resume of the development of the system and the d-c control systems employed.

"5-ZONE REHEAT FURNACE—SOUTH WORKS"

by GEORGE H. KRAPF, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

GEORGE H. KRAPF

Δ THE paper discusses the 5-zone reheat furnaces recently installed for reheating structural blooms for the new 34-in. structural mill at South Works.

Design factors incorporated in the furnace to accomplish the desired rate of production and quality of heating necessary for a mill of this type are reviewed.

"NEW APPROACH TO CENTRALIZED UTILITY DISPATCHING AT FAIRLESS WORKS"

by F. W. ALLEN, General Foreman Utilities Dispatching, and L. CIZMADIA, Fuel Engineer Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

F. W. ALLEN

L. CIZMADIA

△ THIS paper demonstrates the approach taken by Fairless Works of United States Steel Corp. to achieve more efficient control and more economical utilization of utilities; power, fuel, oxygen, etc.

While utilities rank as one of the largest expenses faced by all steel plants, it is the one over which the least control is generally exercised. In the original conception and design of Fairless Works the conventional methods were used in laying out the utilities department. That is, each of the commodities was considered an individual entity and distributed from separate points and in most cases by separate personnel.

The trend in the steel industry has been one of constant rising costs. It is evident that to remain competitive costs must be reduced. The utilities department at Fairless Works analyzed its operation with this fact in mind. This analysis indicated that if greater economies were to be achieved, a new concept of utilities operation must be evolved. Accordingly, the problems found in the old concept of operation were examined and it was determined that grouping under two principal headings was possible.

1. Cascading of impasses from one point to another and one utilities commodity to another.
2. Less than maximum utilization of waste fuels, plant generated power and other commodities.

Analysis of these problems pointed the way to the new concept of operation that was needed. To effectively prevent cascading, and obtain maximum utilization of commodities, the entire utilities function must be correlated; commodity to commodity and utilities to mill operation.

After the problem had been clearly defined the solution became apparent. The proper operational and cost control of utility commodities can only be realized when all of the information pertinent to correlation of operations has been brought to a central location, where one man can decide quickly and intelligently what steps need to be taken to: (1) assure maximum economical utilization of commodities, and (2) localize any impass and institute immediate corrective action to minimize its effect.

The paper demonstrates the steps taken to achieve this in a mill already operating in the conventional manner, the automation of various facilities, the problems encountered in the telemetering of information to a central location, and the reorganization and training of personnel involved.

"WASTE HEAT BOILER APPLICATIONS AT THE INLAND STEEL CO."

by W. M. DOUGLAS, Assistant Superintendent (Power, Steam & Combustion Depts.), Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

W. M. DOUGLAS

△ THE tremendous quantity of heat required in steelmaking processes is evident to those working in the mills and also to any who have seen the red glow in the sky at night or the white heat of metal as it pours from a furnace. Much of the heat from the various steelmaking processes leaves the furnace or pit as flue gas at temperatures that make it economically feasible to recover the heat for preheating combustion air or generating steam. This paper deals with the recovery of waste heat with boilers to generate steam.

Inland's first application to recover waste heat was made over 50 years ago when the No. 1 open hearth shop was built. Two waste heat boilers were installed at this time and their beginning has grown to 55 waste heat boilers that are now operated at Inland. There are five waste heat boiler houses, three separate groups of waste heat boilers located in open hearth shops, and two recovering heat from soaking pits. The combined installed capacity of these 55 units is 1,070,000 lb of steam per hr.

Waste heat is a variable quantity that is dependent on furnace or pit operations. As a result of this variable, Inland has added auxiliary burners to several waste heat boilers to insure a dependable steam supply. The application of auxiliary firing, selection of boilers, cleaning boiler surfaces and other related subjects are presented in this paper on waste heat boiler applications.

"A STANDARDIZED METHOD FOR RATING ROLLER BEARING LOAD-CARRYING CAPACITY"

by E. C. DENNÉ, JR., Assistant Chief Engineer, SKF Industries Inc., Philadelphia, Pa.

E. C. DENNÉ, JR.

△ IF a roller bearing is to give reasonable performance, there is an obvious need for a method to select the right size with confidence. Bearings have lives as do people and light bulbs. Prediction of bearing life is based on an accurate determination of the applied load and the ability of the bearing to carry this load. Individual bearing manufacturers have developed and applied their own methods of rating bearings. As a result, users have been confused by marked differences in the capacities claimed by various companies for the same type and size of bearing. In an attempt to eliminate this confusion, the writer's company has published a method of rating bearings based on years of testing and study. This method is discussed in plain language with

emphasis on the variables that affect bearing ratings and the importance of each to the over all rating. This "erector set" of rating knowledge will permit the user to check and compare bearing ratings on the same basis.

"WHY STRAIGHT CYLINDRICAL BEARINGS IN THE STEEL INDUSTRY?"

by PHILIP H. HUTCHINSON, Manager, Pittsburgh Zone, Hyatt Bearing Div., General Motors Corp., Pittsburgh, Pa.

P. H. HUTCHINSON

△ THE selection of the type bearing required for a specific application is often as much a problem to the designer as the selection of a bearing of proper capacity.

The inherent characteristics of the straight cylindrical bearing, and the economics involved in their use are discussed and related to a number of major steel mill applications.

A number of basic types of straight cylindrical bearings are available and their advantages and disadvantages should be understood in order to select the proper bearing. Environmental factors and maintenance consideration are also important.

The change from plain friction bearings to rolling element bearings has had its effect on establishing lines of bearings to fit the same dimensional restrictions. The tax laws controlling the depreciating of new equipment has had its effect on attempts to standardize bearings in the industry.

An analysis of major cylindrical bearing applications in the steel industry tends to point out some of the advantages and disadvantages of straight cylindrical bearings.

A major application for anti-friction bearings in the industry is roller tables. Selection is based on whether roller neck size dictates bearing bore size, or whether loads are the major consideration. The accurate determination of bearing life is not possible; however using maximum design conditions and known service life, a relationship can be developed.

More industrial type mill cars are equipped with straight cylindrical bearings than any other type. In most cases, particularly on ingot and charging cars, the most severe loading conditions take place in a radial direction while the car is in a static condition. On the surface the use of bronze thrust blocks for location appears to be "horse and buggy engineering," but when all factors are considered it may still be justified. Flange race bearings may be used to eliminate external means of taking location.

Overhead traveling cranes represent an important area of bearing applications in the steel industry. Standards have been established for track wheel bearing selections. The application of straight cylindrical bearings for sheave blocks also offers many design advantages.

One of the oldest applications of flanged race bearings in the steel industry is in the AISE 600 series d-c mill motor. Application offers longer life in given annulus and affords ease of handling for maintenance. Selection of type and size of bearing for steel mill applications is not black magic; however, at the same time it is not an exact science. Consideration of loads and speeds is not enough. The environmental conditions, the skill of the people who maintain the equipment, and economics are equally important points to consider.

"LIFE DISPERSION OF ANTI-FRICTION BEARINGS"

by L. E. ROOT, Senior Engineer, Rollway Bearing Co., Inc., Syracuse, N. Y.

L. E. ROOT

△ THE general categories of anti-friction bearing failures are listed and briefly explained. The causes and types of anti-friction bearing failures are described in terms of the new language of the rapidly expanding science of reliability. The concern of both bearing manufacturer and bearing user about bearing failure rate is historically traced, and an explanation is offered to account for the newly heightened interest in anti-friction bearing life dispersion.

A statistical means of analyzing bearing failures, either from physical laboratory tests or from known field-service experience, is presented, with an attempt being made to present statistical concepts and mathematical treatment in a simplified manner. Several observations of possible obtainable variations in bearing life dispersion are pointed out, together with their implicit meaning, especially as regards an improved life-dispersion characteristic with its accompanying benefits to the user of anti-friction bearings in the form of greater bearing capacity and improved reliability.

Some suggested avenues of approach toward the realization of a more favorable bearing life dispersion characteristic are offered, with specific recommendations directed to the men concerned with mechanical and electrical shop supervision, factory engineers, metallurgists and other technicians and the bearing manufacturers themselves.

Possible limits of improvement in the anticipated anti-friction bearing life dispersion characteristic are examined in the light of available life dispersion observations from recent laboratory fatigue tests of special anti-friction bearings and bearing components alone. Finally, the dispersion characteristics exhibited by other related and nonrelated phenomena are indicated, as a matter of general interest.

"OBSERVATIONS OF THE STEEL INDUSTRY IN INDIA AND JAPAN"

by JOHN L. YOUNG, Vice President-Engineering Technology, United States Steel Corp., Pittsburgh, Pa.

△ THE growing economies of both India and Japan are outstanding. Japan was destitute at the end of

JOHN L. YOUNG

World War II but has bounced back with great strides. The iron and steel industry was wrecked during the war but this year about 20,000,000 ingot tons will be produced and by 1970 the ingot tonnage is planned to be about 42,000,000 tons.

The literacy of the 90,000,000 people is nearly 100 per cent.

Practically all raw materials for making iron must be imported. Exports of finished products are vital to existence.

India has been a sleeping nation for generations but since gaining independence in 1946, internal strife has been quelled and the five year plans are starting to click.

Literacy is less than 20 per cent.

Raw materials for making iron are among the best with the world's largest supply in close proximity to one another. The cost of producing iron and steel can be the lowest in the world. Exports are necessary to develop foreign exchange primarily for the purchase of capital goods until indigenous manufacture can make India self-sufficient for the more than 415,000,000 people.

The per capita use of steel for major nations shows India among the lowest. Last year the capacity of the two principal steel plants was under 2,000,000 ingot tons. Within the next few months the planned expansion under the second five year plan will raise this capacity to 6,900,000 ingot tons. The third plan, scheduled to start in April of next year, will raise this capacity to around 11,000,000 ingot tons. The succeeding five year plans are presently designed to double the capacity in each five year period with a goal of over 50,000,000 ingot tons by 1975.

"REPORT ON THE PRESENT ACHIEVEMENTS AND THE IMMEDIATE PROSPECTS OF DEVELOPMENT OF SOVIET FERROUS METALLURGY"

by IVAN DENISENKO, Economist, Economic Research Institute, and ROMAN BELAN, Metallurgical Engineer, Head, Iron and Steel Industry Dept., State Planning Commission, USSR.

IVAN DENISENKO

△ THE USSR changed from a backward country into a country with highly developed industry in a historically short span of time. In order to raise the whole industry it is necessary to setup a large scale iron and steel industry, one of the foundation-stones of development of the national economy. The Soviet Union occupied first place in Europe and second place in the world (after the USA) in ferrous metal production.

The ferrous metallurgical industry developed at a high rate before the Second World War: this branch of industry was given considerable attention in the five-year economic development plans. This was the period when the second iron and steel base was setup in the Eastern regions of the country. High-quality metallurgy came into existence in the USSR in the period of the early five-year plans.

ROMAN BELAN

The ferrous metallurgical industry suffered tremendous loss in the years of the last war. The principal iron and steel base in the Ukraine and in the central regions of the country was destroyed. However, right after the war the industry was restored swiftly and on a new technical basis. Many functioning plants were modernized and new mills were built.

Along with the increase in capacities of iron and steel mills, great attention was devoted in the postwar years to their better use, and to the introduction of new technology. Work proceeded apace in increasing the capacities of metallurgical equipment, speeding up metallurgical processes, increasing the lifetime of the steel furnaces, enriching iron ore and improving preparations for its smelting.

The USSR drew up a new plan in 1958 for a further great advance of all branches of the national economy. This plan embraces a seven-year period (1959–65). One of the most vital tasks set by this plan is to accelerate the development of the ferrous metallurgy and especially its iron ore base. Ferrous metallurgy will continue to develop rapidly after 1965 as well.

The first year of the seven-year plan period has shown that this vast program will be overfulfilled and it is expected that considerably more than 86 to 91,000,000 tons of steel will be received in 1965. There will also be more pig iron and rolled metal produced than envisaged by the seven-year plan.

The Soviet Union is now elaborating an economic development program for a longer period—for 15 to 20 years. In this plan too the development of ferrous metallurgy will occupy a prominent place.

The main tasks for the coming 10 to 15 years were outlined by N. S. Khrushchev, Chairman of the USSR Council of Ministers, at the jubilee session of the Supreme Soviet in 1957 when the 40th anniversary of the Great October Socialist Revolution was marked. To many people at that time the task of bringing steel production up to 100 to 120,000,000 tons seemed to be unrealistic. This assignment demanded that output of pig iron be raised to 75 to 85,000,000 tons and extraction of iron ore to 250 to 300,000,000 tons. The results of the first year of the seven-year plan period and the higher capacities in the ferrous metallurgical industry at present show that this task can be coped with and that by 1970 considerably more than 120,000,000 tons of steel per annum can be expected.

It is intended to further outline in the report the development of the iron ore base, and the technical standards and economic indices in blast furnace, steel smelting and rolling mill production. New machinery and technological processes will be briefly described.

"COMPUTERS FOR INDUSTRIAL CONTROL"

by R. W. SONNENFELDT, Manager, Engineering, Industrial Computer Systems Dept., Radio Corp. of America, Natick, Mass.

R. W. SONNENFELDT

△ GENERAL purpose digital computers are now making their appearance in industrial plants. For the most part, they do not merely mechanize tasks previously handled by humans but make possible an entirely new era in control of complicated processes. Industrial control computers are now being designed for such applications. This paper discusses in basic terms the characteristics and performance features of industrial computers, and how they can increase process profitability.

Computer speed, memory capacity, kind of memory, mechanical design, programming features, reliability and other specifications are related to requirements of industrial control. A typical application analysis is explained through use of a high-speed tinplate line as an illustrative example. Several suggestions are offered as an aid in the writing of better purchase specifications.

Currently about three years are needed to go from first conception to an operating industrial computer installation. A discussion is given of the many tasks to be completed by user and supplier in this process.

"ANALOG AND DIGITAL TECHNIQUES USED IN ROLLING MILL ELECTRICAL SYSTEMS DESIGN"

by D. E. ABELL, Supervisory Engineer, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

D. E. ABELL

△ HIGHER production speeds and increased accuracy necessitate the use of new techniques in the electrical control systems for rolling mill drives. Many of these techniques are not new in principle, but have been utilized for many years in analog and digital computer work.

The emergence of the transistor as a reliable component has made possible the use of these techniques in industrial applications. The small size, low energy level, high speed of response, and high gain have permitted the design of computer type amplifiers, which perform analog functions in the regulation of any desired parameter.

In a similar fashion, the digital computer has contributed means of counting, sampling, storing and performing other arithmetic and logic functions. The use of all static control components in the design of mill regulating and logic systems provides a power level in the control which is compatible with that of the computer type equipment, thus giving the control systems designer a new concept from which improved performance of mill drive systems results.

"APPLICATION OF DIGITAL COMPUTERS FOR ACCOUNTING AND CONTROL OF CONTINUOUS PROCESSING LINES"

by R. W. KIRKLAND, Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. W. KIRKLAND

△ IN the last 15 years high speed continuous processing lines have largely replaced older batch and sheet processing methods.

Each new installation has been larger, faster, more complex and more efficient than preceding versions. Each of these processing lines now represents a large concentration of the productive capacity of a modern sheet and tin mill.

These lines are at or near the end of the production cycle. The raw material that they handle has a high accumulated value. The process itself is often the last place where product quality can be controlled or classified.

Certain of these lines by virtue of their modern construction, complexity and location in the production cycle have proved to be admirably suited for the application of digital control computers.

These computers are multi-purpose designs providing direct connections to the sheet and tin mill accounting systems as well as operating to achieve optimum process control.

The further development of plant wide integrated automation systems will develop uses for on-line digital computer type systems for inventory and accounting purposes on many processes that are as yet too simple to justify advanced control systems.

Suggested systems for several processes are functionally described to illustrate the contributions of on-line digital computers.

"PRESSURE DROP REGULATION CLOSES THE BLAST FURNACE CONTROL LOOP"

by OTTO J. LEONE, Consulting Engineer, West Newton, Pa.

OTTO J. LEONE

△ PRESSURE-DROPS caused by gas flows through the blast furnace stock column vary randomly and widely in all blast furnaces except those adapted to use pressure-drop control. It is impossible to predict the pressure drop with sufficient accuracy for control significance in blast furnaces not equipped to use the pressure drop method; it can be predicted, however, by the use of pressure drop control if adequate controllability is provided to meet operating conditions. The paper discusses the limiting effects of high pressure drops on maximum blowing rates, hot blast temper-

atures and iron production. Means for minimizing or removing these limitations and improving furnace operations by the measurement and control of pressure drops through the stock column are considered.

The effects of certain variables on pressure-drop, such as blowing rate, hot blast and gas temperatures, particle size, variations on stock permeability or voids-fraction, furnace gas pressures, moisture and gas additions to the blast and other factors are reviewed. The relative effectiveness of varying different factors for pressure drop control purposes are compared.

Of the many instruments used in everyday blast furnace operations, except for the stock-line recorder, none of them indicates conditions actually existing inside the stock column proper. A measurement based on the pressure drops between two or more elevation levels, however, does provide a fast and reliable indication of such conditions as the fluid dynamics and gas-solid contact in the stock column. Changes in pressure drop are related to changes in voids-faction, heat transfer characteristics, gas velocities, gas retention-time in the furnace, dust production and other variables which affect furnace performance. When applying the pressure drop method to control a blast furnace, in effect, the stock column conditions become part of the control loop; any changes in the column dynamics from normal are quickly detected as changes in resistance to gas flow, so that furnace control variables may be regulated to compensate for deviations from optimal conditions.

The advantages and limitations of top pressure control are discussed in relation to pressure drop and other factors which affect resistance to gas flow. The advantage of applying the differential pressure control method to high top pressure furnaces are considered.

"LIMITATIONS OF BLAST FURNACE STOVES"

by T. R. SCHUERGER, Supervising Technologist, and DR. J. C. AGARWAL, Research Technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

T. R. SCHUERGER

DR. J. C. AGARWAL

△ MODERN blast-furnace practice relies more and more on the blast-furnace stove as a source of thermal energy for the iron-making process. Ever increasing blast volumes and blast temperatures are being called for by the blast-furnace operators, and more stringent, or limiting, conditions are placed on stove design and stove operation.

The blast-furnace stove is a regenerative heat exchanger and is discussed in the literature as such. For many years, the theory of regenerators has been investigated, but only recently has the true thermodynamic nature of regenerators been accurately described mathematically.

A limitation in the design of blast-furnace stoves is our inability to manipulate this complex thermodynamic description of the regenerator. Another limitation is lack of knowledge of heat-transfer coefficients. In many practical cases of actual stove operation, insufficient information is available for the calculation of simple heat balances and stove-firing rates.

Physical limitations in firing stoves are maximum refractory and stack temperatures. Actual data from operating stoves indicate that it should be possible to overcome many of the hypothetical limitations on stove operation by properly designing and firing the stoves.

"THE USE OF NATURAL GAS IN BLAST FURNACES AT THE PUEBLO PLANT OF THE CF&I CORP."

by JOHN M. NEGOMIR, Practiceman, Blast Furnace Dept., Pueblo Plant, The Colorado Fuel and Iron Corp., Pueblo, Colo.

JOHN M. NEGOMIR

△ THE use of natural gas in blast furnaces has been under development at the Pueblo plant of the CF&I Corp. for nearly two years. One furnace has been operated continually with natural gas injection for more than a year, and construction now underway will make it possible to use natural gas as part of the regular operation on all four of the Pueblo furnaces.

The first actual injection of natural gas into a furnace was made in November, 1958, and by June, 1959 a complete supply and control system was put into service This sytem has been in constant use since installation. The natural gas has been injected into the blowstocks or blowpipes. This method has proved to be satisfactory for the furnace operation, but the blowpipes must be protected against extremely high temperatures. Injection through specially constructed tuyeres is now being tested.

A convincing coke saving was obtained in July, 1959, and since then a coke rate reduction of 75 lb per 1000 standard cu ft of gas has been realized over extended periods of time. Blast temperature is very critical to furnace performance, and has limited the gas usage to 5 per cent of the wind volume.

Although further improvements in the techniques of using the natural gas are anticipated, the process is well enough developed to install on all of the furnaces. The relative costs of coke and natural gas have justified the immediate installation and use of natural gas injection as part of the regular blast furnace operation.

"THE NEXT STEP IN STEEL PLANT DATA PROCESSING"

by W. N. SPRAY, Manager, Methods & Procedures, Production Planning Div., United States Steel Corp., Pittsburgh, Pa.

△ THE increasing success of the many projects in which electronic data processing is applied to production and sales functions is intensifying the problem of physical communications in steel plants. It is likely

W. N. SPRAY

that the next five years will be a period of revolutionary development and application in communication networks, comparable to the surge of computer applications in the last five years.

On the "hardware" side there is now a wide variety of radically new devices available for use. But on the application side, there are very difficult problems in analysis and design of systems which will have to be solved before communications installations can unlock the real potential of data processing centers.

One of the most difficult problems lies in the complexity and the physical dispersion of both the sales-production information flow and the parallel physical product flow. To understand these flows fully and analytically is a prerequisite to the construction of workable communications networks. In this area the so-called "total" approach is just as critical as in the data processing center itself.

"MINIMIZING POLLUTION FROM PICKLING LINES: AUTOMATIC CONTROL OF STRIP PICKLING BATH COMPOSITION"

by C. W. SHINGLEDECKER, Research Engineer, Bethlehem Steel Co., Bethlehem, Pa.

C. W. SHINGLEDECKER

Δ AN important way to minimize acid pollution from pickling is to use the acid as efficiently as possible. This paper describes the development of an automatic bath-composition controller which has proved effective in minimizing pollution from continuous strip-pickling lines.

Continuous strip-pickling lines commonly employ four or five pickling and two rinse tanks, with acid and water being added to the tank from which the strip emerges, and the pickling bath becoming spent as it flows through the other tanks, countercurrent to the movement of the strip.

Studies of the strip-pickling operations showed two major problems: a wide fluctuation in bath compositions, and considerable acid drag-out into the rinse tanks. Drag-out was controlled by installing rubber rolls and water sprays on the strip-exit tank. Variations in bath composition were overcome with automatic controls.

Since a satisfactory bath-composition control system was not commercially available, the development of a suitable system was undertaken by the research department in co-operation with the Sparrows Point plant. Initial studies revealed that if a uniform composition could be maintained in the final pickling tank, the tank to which make-up water and acid are added, the composition in the other tanks would remain constant, and there would be a reduction in acid consumption. A method of maintaining uniform composition in the final tank was soon found. This method is based on the observed fact that for a given specific gravity and conductivity, a pickling solution can have only one iron content and one free acid content. Based on this observed fact, a control principle was developed whereby gravity and conductivity-sensitive instruments could be set at predetermined values, and the addition of make-up acid would be automatically regulated to maintain the desired bath composition.

Suitable sensing devices and control equipment were installed on one of the continuous strip-pickling lines at Sparrows Point in September, 1956. The system was developed cautiously over the next six-month period, and by March, 1957, the automatic bath-composition controls had been found to be acceptable.

The system has proved to be very satisfactory: about 10 to 25 per cent less acid is consumed and pickling is more uniform.

Automatic controls are now in service on four of the seven continuous strip-pickling lines at Sparrows Point, and the remaining three lines are now being similarly equipped. The Lackawanna plant has recently put a similar unit into operation, and they expect to equip the remaining two lines.

Patent No. 2,927,871, covering this control system, has been granted to Bethlehem.

"STEPS TOWARD COKE PLANT AUTOMATION"

by N. F. AGNEW, Vice President, Femco, Inc., Irwin, Pa.

N. F. AGNEW

Δ THIS paper deals with automation as it has been and can be applied to various operations involved in the production of coke, especially the operations which may be classified as materials handling.

Almost all of the equipment necessary to automate coke plant operations has been used for a number of years in other steel plant applications. These applications include carrier communication systems on moving equipment; interlocking systems; systems for data transmission, telemetering and monitoring; remote control of moving equipment; remote control from moving equipment; automatic operation of ingot buggies, and many others.

The problem has been to select, from equipment and methods already in use, those elements best suited to coke plant needs and to develop systems individually engineered for specific applications—and to do this at a cost which is well in line with savings.

The first such system to be developed was quench car automation. This system enables the door machine operator, by remote control, to bring the car to the coke guide. From there on the operating cycle is automatic. The car moves under the coke guide at a rate which is controlled by ram movement; travels to the quench tower, then to the coke wharf; positions itself and dumps the coke; then moves away from the wharf and waits until "called" again by the door machine operator.

This system was followed by one for a battery of Mitchell ovens now under construction. In this instal-

lation leveler and pusher are separate machines. Coke is quenched in the ovens, pushed onto a conveyor which loads it into cars, then taken to a crusher and automatically dumped.

The conveyor operator also operates the locomotive and the pusher, both by remote control. The leveler operator controls the larry car. When the larry is returned to the hoppers, it is automatically stopped, centered and filled with a weighed amount of coal.

Larry cars on by-product batteries can be operated in essentially the same way, with the added feature of "programmed" leveling interlocked with the charging operation to insure uniform distribution of the charge.

A similar system could be used to load coke into railroad cars at a screening station. Such a system would detect the approach of a car, measure the weight as the car is filled, move the car along for even distribution of coke. By interlocking with the conveyor system, loading can continue automatically as long as coke and cars are available.

Still another system, not differing greatly from this, could detect the amount of coal in a car as it arrives on plant property, and make every handling and processing step automatic including the delivery of proper amounts of coal to the bunkers at the coke battery.

These are just a few of the things that can be done with knowledge and equipment already available What actually will be done, and when it will be done, depends on the needs and interests of the industry.

CURRENT AISE DISTRICT SECTION MEETING NOTICES*

BIRMINGHAM SECTION

Monday, October 24, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Communication and Air Defense," by A. C. Boyd, Alabama Staff Engineer—Personnel, Southern Bell Telephone and Telegraphic Co. Film: Dew Line Story

Guest House Motel

BUFFALO SECTION

Tuesday, October 11, 1960—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Wire and Wire Products," by W. O. Everling, Director of Research, American Steel and Wire Div., U. S. Steel Corp., Cleveland, Ohio.

Sheraton Hotel, 715 Delaware Ave., Buffalo, N.Y.

CANTON SECTION

Monday, October 17, 1960.

Inspection Trip to Morgan Engineering Co., Alliance, Ohio. Details later.

CLEVELAND SECTION

Tuesday, October 25, 1960—Dinner 6:30 P.M., Meeting 7:45 P.M.

"European Steel Mill Practice," Speaker to be announced.

Cleveland Engineering and Scientific Center, 3100 Chester Ave., Cleveland, Ohio

COLORADO SECTION

Tuesday, October 18, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Solving Operating Problems wih Electronic Computers," by Wm. O. Blattner, Industrial Engineer, Special Assignment, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Tuesday, October 11, 1960—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Use of Oxygen in Steelmaking," Panel discussion presented by Ralph Duffett, Jr., Superintendent of Open Hearths and Bessemer, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich.; C. C. Benton, Division Superintendent Blast Furnaces and Basic Oxygen Process, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada; George Ferris, Manager, Open Hearth Furnaces, Steel Div., Ford Motor Co., Dearborn, Mich.

Engineering Society of Detroit, 100 Farnsworth, Detroit, Mich.

LOS ANGELES SECTION

Monday, October 10, 1960—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"How to Get and Use Rolling Mill Power Data," by A. J. Winchester, Chief Electrical Engineer, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio.

Michaels Restaurant, Telegraph Rd. and Washington Blvd., Los Angeles, Calif.

ST. LOUIS SECTION

Wednesday, October 26, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Use of Oxygen in Metal Working Industry" Speaker to be announced

Elks Club, Granite City, Ill.

UTAH SECTION

Monday, October 10, 1960 (Date Tentative) Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"U. S. Depreciation Policies and Their Effects on Steel Industry," by Honorable Wallace F. Bennett, Senator from Utah

Grandview Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, October 24, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Oxy-Fuel Processes," by E. F. Kurzinski, Manager, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

Mahoning Country Club, Girard, Ohio

* Sections not listed have no meetings.

Design Consideration of Bag Houses for Use in Electric Furnace Operations

by STEFAN EPURE,
Consulting Engineer,
San Marino, Calif.

. . . . with the advent of more stringent smoke control legislation, further thought has been applied to electric furnace fume collection and cleaning problems . . . .

THE latest developments in the art of making steel call for strict governmental regulations covering the control of fumes formed during the steel generating processes. To comply with these requirements, much study and research work have been done and a tremendous amount of literature written on the subject, both here and abroad. Nevertheless none of the papers available at this time suggests a more or less general method or formula to be applied in connection with the various kinds of equipment used in making steel.

It is well known that the amount and nature of the effluent fumes vary, depending on the metallurgical process used and the corresponding equipment considered. What distinguishes the fumes generated during any steelmaking process from those coming from another metallurgical process is their high temperature and the extreme fineness of the matter in suspension in the effluent gases. In particular, fumes generated in electric furnaces when making steel out of scrap have a high temperature, around 3000 F, consist of a mixture of CO, CO_2 and $2N_2$, with CO in excess for standard reducing operations without using oxygen. They have in suspension particulate matter of submicron size, are composed of approximately 50 per cent FeO at atmospheric pressure and are accompanied by sparks depending on the cleanliness of the scrap used in the charge. Furthermore the rate of generation of the fumes is not uniform over the entire heat cycle. Approximately 75 per cent of the fumes are emitted during the meltdown period, whereas the remaining 25 per cent are produced during the refining period.

As such, the design of adequate gas cleaning equipment should be based, not on the average hourly production rate of the entire steelmaking cycle as a whole, but on the actual operating cycle consisting of the two above-mentioned periods, each with its own specific production rate.

During the meltdown period the production rate is higher and depends on the furnace transformer size. Considering an average consumption of 500 kw hrs per ton of finished liquid steel, out of which ¾ is being used for melting down the cold charge and ¼ for refining it, the meltdown time, T_{hr}, is obtained from the following obvious equation:

$$T_{hr} = \frac{(500 \text{ kwhr/ton})\ (3/4)\ (Q \text{ ton/heat})}{(W_{kva})\ \cos\varphi = 0.85} \qquad (1)$$

where Q is the heat size in tons and W the available transformer power in kva, at a power factor of 0.85, as usually considered in normal operations.

After performing the required algebra, the above formula yields the rate of production, P, in tons per hr during meltdown, in the form

$$P_{ton/hr} = \frac{Q_{ton}}{T_{hr}} = \frac{Q_{ton}}{440\ Q_{ton}/W_{kva}} = \frac{W_{kva}}{440} \qquad (2)$$

Applying the above two equations to various sizes of electric furnaces, there results Table I.

Comparing the meltdown time with the actual total heat time, it may be concluded that the meltdown time is approximately equal to the refining time, which leads

TABLE I
Operating Characteristics of Various Electric Furnaces

Size of heat, tons	Transformer power, kva	Meltdown time, T_{hr}	Meltdown rate, $P_{ton\ per\ hr}$	Average heat cycle, hr
20	7500	1.167	17	2
40	12,500	1.40	28.5	3
100	25,000	1.75	56.75	4

to the previously-estimated distribution of fume generation between the melting down and refining periods in the ratio of 3 to 1. According to technical works published here and abroad, it may be assumed that one ton of molten steel produces approximately 6000 scf of gas over the entire heat period, at a density of 0.06 per scf and, therefore, approximately 360 lb per ton of molten steel, out of which $^3/_4$ is generated during the meltdown period. The preceding assumes a good average quality of scrap. Under the worst of conditions, when the scrap used is dirty the amount of fume generation doubles.

The dust of the particulate matter in suspension in the effluent gas is generated at a rate of 10 to 20 lb per ton of molten steel, depending on the quality and cleanliness of the scrap used. On the basis of 12 lb per ton, the dust load per unit volume of gas generated at a rate of 6000 scf per ton of molten steel is then given by:

$$\frac{(12 \text{ lb/ton})\ (7000 \text{ grains/lb})}{6000 \text{ scf/ton}} = 14 \frac{\text{grains}}{\text{scf of gas}} \quad (3)$$

The above figure is assumed to be a constant, whether or not the meltdown or refining periods are considered, due to the linear relationship between the dust load and the rate of generation of the fumes, at least in a first approximation.

Considering the above discussion, the assumptions on which the design of certain gas cleaning equipment should be based, may fall within the following limits:

1. Temperature of hot effluent, 3000F.
2. Rate of fume generation during meltdown period, 270 lb per ton, 4500 scf ton.
3. Dust load or concentration during meltdown period, 9 lb per ton, 14 grain per scf.
4. For dirty scrap, the figures under items 2 and 3, above, double.

However, before cleaning the above effluents, there are two more problems which the designer should consider, namely: collection of the fumes and conditioning of the fumes.

At present there are three systems for collecting fumes generated by electric furnaces, each of which is a determining factor in the relationship between the volume and temperature of the effluent gas to be processed:

1. The canopy type hoods, located above the furnace, require large volumes of in-draft air, which results in lower gas temperature.

2. Indirect collection, by means of roofring hoods closely fitted around the electrodes, doors and pouring spouts, and equipped with a disconnecting flange in the exhaust duct, to allow for the furnace movement. This system is more complicated but does not involve an oxidizing atmosphere within the electric furnace.

3. Direct collection, by aspiring directly the fumes generated within the furnace, through a water-jacketed opening in the roof, the furnace itself being considered as a collecting hood. This system is by far the simplest and results in complete collection of the generated fumes. Nevertheless it involves cold air infiltration into the furnace shell, which is working, in this case, in depression, below the atmospheric pressure and, consequently, yields an oxidizing atmosphere within the furnace laboratory, which might be detrimental for normal operations. Furthermore, the effluent to be further processed is at a very high temperature and within the range mentioned previously. Nevertheless, in most cases where larger size electric furnaces have been installed recently, this latter type of fume collection was preferred.

Further discussions will therefore consider this type of collection, with the effluent temperature assumed to be 3000 F, although the methods described below may be applied to other types of collection as well, except for the initial fume temperature, which should be considered lower in the range of 2000 F for the roofring hood.

Due to the high content of CO, which results in a high toxicity and in an explosion danger, as well as the high temperature involved, which no gas processing equipment will withstand, it becomes necessary to modify the characteristic properties of the dust-loaded gas before cleaning it.

It is always necessary to dilute the effluent with fresh air, for complete combustion of the CO content and to bring the temperature to about 3000 F average. This amount of dilution air depends on the melting process used, i.e., on the chemical composition of the gases, whether a reducing or oxidizing atmosphere is contemplated, and whether or not oxygen is used in the process. Further addition of dilution air will reduce the temperature of the gases so as to yield a satisfactory concentration of the dust load, which is to be properly handled by the gas cleaning equipment considered within its performance capabilities. None the less, this primary air dilution should be kept at a minimum in order to avoid as much as possible cold air infiltration, with its oxidizing effect on the heat.

Therefore, assuming, for the above reasons, a dilution in the ratio of 2.5 to 1 for the hot gases (270 lb per ton), at 3000 F, with surrounding air at 140 F, there will result a mixture of air and gas at a temperature of

$$\frac{270\ (3000 + 460) + (2.5)\ (270)\ (140 + 460)}{(3.5)(270)} = 1417 \text{ R} \quad (4)$$

or

$$t = 1417 \text{ R} - 460 = 957 \text{ F}$$

Hence the first suggested step in processing the hot effluent is a dilution in the ratio of 2.5 to 1 with fresh air, resulting in a reduction of the temperature from 3000 F to around 950 F, including a reasonable margin, with respect to the above figure obtained by computation.

Without going into too much detail it becomes necessary, at this point, to digress and discuss in brief the various gas cleaning methods available up to the present time. It is a well-known fact that there are at present two methods of alleviating the effluent gas from its dust load, the dry method and the humid method. Generally speaking the dry process is simpler and less expensive, whereas the humid process is more flexible, but more costly to install. Furthermore the humid process is more adequate for applications dealing with gases for which the dust load particle size is below 0.5 microns.

The dry process is represented by various types of

TABLE II
Gas Cleaning Equipment

	Dry Process			Humid Process		
	Multi-Cyclone	Bag house	Electrostatic Precipitators	Electrostatic Precipitators	Disintegrator	Venturi
Efficiency for submicron particles in per cent	40	99.7	70	92	92	97
Investment cost	0.225	1	1.15	1.75	0.85	0.50
Operating cost	0.5	1	0.15	0.5	4.5	2.25

multicyclones, bag houses and dry electrostatic precipitators, while the humid process is represented by various types of Venturi washers, disintegrators and humid electrostatic precipitators. A general comparison of the salient points of interest of these processes is given in Table II, where the bag filtering dry process has been considered as a unity.

Taking into consideration the above data, the operating ranges of the various types of gas cleaning equipment on hand and other operating requirements related to the humidity and temperature of the gases to be cleaned, it seems that the bag house and humid electrostatic precipitator are the most suitable types of equipment for use in connection with electric furnace operation. Furthermore, since a humid process involves corrosion problems we have chosen the bag house as the representative type of gas cleaning equipment for the above purpose. As such, further discussion contemplates the use of a bag house for eliminating fumes when melting steel in electric furnaces.

Coming back to our design process, it can be stated that the dilution recommended presents the advantage of requiring the least amount of cloth for filtering, for a standard ratio of gas mixture to cloth of 2:1 to 4:1, and the smallest investment cost in the bag house, together with the smallest amount of operating trouble and operating and maintenance costs, the latter increase in a certain ratio with the increase in size of the gas cleaning equipment.

The next step is to cool the mixture of gas and air, from 950 F to 750 F, in order to carry it through a duct to the bag house. This step becomes necessary since it is felt that 750 F is an upper temperature limit which a galvanized duct will safely withstand. This cooling will take place in a separate chamber, usually located near the electric furnace under consideration and designated by the name "spark box" or "flame trap," since it also serves the purpose of catching the unavoidable sparks and flames which accompany the effluent gas leaving the furnace shell.

The cooling medium is water, sprayed by means of automatically-controlled nozzles in proportion to the end temperature of the mixture requirements. The computation of the amount of water needed for cooling the gases through the above range is elementary and will not be repeated here. Nevertheless it must be pointed out that, since the filtering of gas through bags is essentially a dry process, care must be taken that the amount of water sprayed for cooling yields a mixture of gas vapor having a dew point lower than the temperature of the gas leaving the bag house. Therefore the amount of water sprayed depends on operating conditions and on the requirements of a satisfactory dew point.

The third step involves further cooling of the gas mixture from 750 F to a lower temperature acceptable for the bags without scorching, so that they will not be damaged and have to be replaced frequently, which would present high maintenance and high operating costs from downtime during repairs.

If the bags are of the silicone-impregnated type, they can stand 500 F, and, therefore, if a lower cooling temperature of 350 F is assumed, one-third of the bags' heat resistance capabilities still remains as a safety margin.

If the bags are made of dacron or orlon cloth, then they can stand only 250 F, so that the lower cooling temperature, in this case, would only be 175 F, to assure the same safety margin of approximately one-third of their heat resistance.

Considering, for the purpose of this discussion, the use of silicone-impregnated bags, the range of cooling in this third step should be from 750 to 350 F. The cooling may take place in any kind of heat exchanger, the simplest one being an ordinary duct acting like a radiator and to which radiating fins could eventually be added, for greater effect. This duct is sized so as to yield an average gas velocity of around 3500 fpm, on the hot side. To be on the conservative side, the duct is further sized according to the radiation effect, discarding the heat transfer by convection. Furthermore the duct may be either in a straight line or in a more compact form, i.e., provided with several bends and reversals of the flow direction, in every case the exhaust fan being sized accordingly. The radiation area involved is determined by the amount of heat loss through the radiator. Assuming a specific heat of 0.25 Btu per lb per F of the gas mixture, and taking into consideration the previously-mentioned characteristic quantities, there results:

$$\text{A gas mixture} = 270 + 2.5 \times 270 = 945 \text{ lb per ton at 0.25 Btu per lb per deg F}$$

$$\text{A heat loss} = 945 \times 0.25 \times (750 - 350) = 94{,}500 \text{ Btu per ton} \quad (5)$$

For a rate of production $P_{\text{ton per hr}}$, as defined previously, this will then lead to

$$\text{A heat loss} = 94{,}500 \frac{\text{Btu}}{\text{ton}} \times P \frac{\text{ton}}{\text{hr}} = 94{,}500P \frac{\text{Btu}}{\text{hr}} \quad (6)$$

The amount of heat transferred through radiation per sq ft and per hr of the radiating duct for the above temperature differential is then obtained as usual, for both ends of the duct, from the standard formula:

$$Q' = 1.73 \times 10^{-9} \times \epsilon \times [(750 + 460)^4 - (70 + 460)^4] = 1.73 \times \epsilon \times 2.0646 \times 10^3 \frac{\text{Btu}}{\text{hr per sq ft}}$$

$$Q'' = 1.73 \times 10^{-9} \times \epsilon \times [(350 + 460)^4 - (70 + 460)^4] =$$

$$1.73 \times \epsilon \times 0.3519 \times 10^3 \frac{\text{Btu}}{\text{hr per sq ft}} \quad (7)$$

where ϵ is the radiation coefficient. Assuming further, in a first approximation, a linear decay of the temperature along the duct, there further results

$$Q = 1.73 \times \epsilon \times \left[\frac{2.0646 + 0.3519}{2}\right] \times 10^3 =$$

$$1.73 \times \epsilon \times 10^3 \times 1.2 \frac{\text{Btu}}{\text{hr per sq ft}} \quad (8)$$

and therefore:

$$Q = 2075 \times \epsilon \frac{\text{Btu}}{\text{hr per sq ft}}$$

where ϵ is the emissivity, depending on the surface condition of the tubular radiator. Consequently the necessary radiating surface of the duct, to eliminate the above heat loss and cool down gasses from 750 to 350 F, is:

$$S = \frac{\text{Heat Loss, Btu/hr}}{Q \text{ Btu/hr per sq ft}} = \frac{94{,}500 \text{ Btu/hr}}{2075 \times \epsilon \text{ Btu/hr per sq ft}} = 45.54 \frac{P}{\epsilon} \text{ sq ft} \quad (9)$$

The emissivity coefficient being assumed to be $\epsilon = 0.95$, the above formula yields

$$S = 47.5P \text{ sq ft} \quad (10)$$

The fourth step in processing the effluent gases involves the cleaning of the particulate matter in suspension in compliance with local conditions and ordinances. The gases arrive at the silicone-impregnated bag house at 350 F, as described above.

In this case the 945 lb per ton of mixture of gas and air yields, at a density of 0.06 lb per cu ft, a volume of 15,750 scf per ton, which results, at the above temperature, in a volume of

$$V = (15{,}750) \frac{350 + 460}{70 + 460} = (15{,}750)\ (1.53) = 24{,}000 \frac{\text{cu ft}}{\text{ton}} \quad (11)$$

This specific volume can be further related to the specific rate of production during meltdown $P_{\text{ton per hr}}$ as previously defined, with the equation:

$$V = 24{,}000 \frac{\text{cu ft}}{\text{ton}} \left(P \frac{\text{ton}}{\text{hr}}\right) = 24{,}000\ P \frac{\text{cu ft}}{\text{hr}} = 400\ P \text{ cfm} \quad (12)$$

Combining formulae (10) and (12), there results a specific load per radiating surface, in the form

$$\frac{V}{S} = \frac{400 \text{ P cfm}}{47.5P \text{ sq ft}} = 8.4 \frac{\text{cfm}}{\text{sq ft}} \quad (13)$$

which is independent of the scrap quality.

In the preceding discussions and estimations, average operating conditions, i.e., melting of clean scrap, have been considered. When melting dirty scrap, or scrap of doubtful cleanness, the amount of fume generation, as well as the pollutant produced for the same melting rate of production is twice as great. In these circumstances it is safe to consider a larger bag house in the same proportion, which then yields, by formula (12):

$$V = (2)\ 400\ P \text{ cfm or approx. } 800\ P \text{ cfm} \quad (14)$$

This is a basic formula in sizing the bag house, and can be put into the more conventional form

$$V = 400 \frac{\text{cfm}}{1000 \text{ lb per hr}} \text{ at } 350 \text{ F} \quad (15)$$

valid under the above conditions of processing the effluent gas. Accordingly formula (10) changes into

$$S = 95\ P \text{ sq ft} \quad (16)$$

Taking, for example, an electric furnace of a capacity of 40 tons per heat, for which, in accordance with Table I, P = 28.5 tons per hr (the rate of production during the meltdown period), there will result, under the above conditions of processing the effluent gas, a bag house capable of handling:

$$(400) \frac{2000}{1000} (28.5) = 22{,}800 \text{ cfm at } 350 \text{ F}$$

The radiating duct will then have a radiating surface of

$$S = 95 \times 28.5 = 2707.5 \text{ sq ft}$$

Its cross section, A, results, obviously, from:

$$A = \frac{(945) \frac{750 + 460}{70 + 460} (2) \frac{1}{0.06} \frac{\text{cu ft}}{\text{ton}} \left(28.50 \frac{\text{ton}}{\text{hr}}\right)}{(60 \text{ min}) 3500 \text{ fpm}} = 9.70 \text{ sq ft}$$

based on the hot side of the duct. There results, therefore, a diam of 3.50 ft, or approximately 42 in., and, consequently, a length of:

$$L = \frac{2707.5 \text{ sq ft}}{\pi\ 3.50 \text{ ft}} = 245 \text{ ft}$$

In the above circumstances the dust load remains almost constant and, by formula (3), there results a concentration of

$$14 \frac{\text{grains}}{(\text{scf of gas}) \frac{350 + 460}{70 + 460} (3.5)} = \frac{14}{5.355} = 2.625 \frac{\text{grains}}{\text{cu ft}} \quad (17)$$

This implies a cleaning efficiency of the bag house in accordance with the Los Angeles, Calif., code, of, for instance:

$$E = 1 - \frac{0.043}{2.625} = 98.362 \text{ per cent} \quad (18)$$

which is acceptable, according to Table II.

Actually the above-described method of processing the hot gases emitted from an electric furnace during melting suggests the following:

1. An air dilution of the effluent in the ratio 2.5 to 1 thus reducing the temperature from 3000 to 950 F.
2. A primary cooling of the resulting gas mixture

from 950 to 750 F, by means of automatically-controlled spraying nozzles within a spark box, subject to a satisfactory dew point.

3. A secondary cooling of the gases from 750 to 350 F, by means of a radiating duct of a radiating surface S = 95 P sq ft.

4. A cleaning of the resulting effluent at 350 F, in a silicone-impregnated bag house, to handle a volume of V = 800 P cfm.

In the above formulae, P is the melting rate during the meltdown period, as given by P = W/440, where W is the electric furnace transformer power in kva.

This method has the advantage of the smallest amount of cold air in-draft into the furnace and the smallest possible bag house to handle efficiently the hot effluent, in compliance with standard regulations.

The above figures should be considered as average figures, taken from experiments and, therefore, subject to alteration according to specific and local operating conditions. Nevertheless, under any circumstance, the design method, as above described, remains valid for all cases which might come under consideration in practical application.

If, instead of the above method of processing the hot gases, only cooling by air dilution from 3000 F to 350 F had been considered, thus eliminating the primary and secondary cooling, as outlined, then the necessary amount of air would have jumped to

$$\frac{270\,(3000 + 460) + (\eta)\,(270)\,(140 + 460)}{(\eta + 1)\,(270)} = 350 + 460$$

where η is the dilution ratio of air to gas, which yields the equation:

$$\frac{3460 + \eta\,(600)}{\eta + 1} = 810 \text{ or } \eta = 12.6 \qquad (19)$$

Therefore in this case the volume to be handled by the bag house would be

$$\frac{12.6 + 1}{2.5 + 1} = 3.90 \text{ times}$$

as great as in the previous method. This would therefore imply first a greater in-draft of cold air into the furnace, and, secondly, a much larger piece of cleaning equipment, in order to handle 1560 cfm per 1000 lb per hr.

Furthermore, under some circumstances straight air would have been used to cool down gases from 3000 to 175 F instead of 350 F, so as to stand the orlon or dacron bags. Then the required amount of air would be

$$\frac{270\,(3000 + 460) + (\eta)\,(270)\,(140 + 460)}{(\eta + 1)\,(270)} = 175 + 460$$

which yields the equation

$$\frac{3460 + \eta \times 600}{\eta + 1} = 635, \text{ or } \eta = 80.5 \qquad (20)$$

Therefore, in this case the volume to be handled by the bag house would be

$$\frac{80.5 + 1}{2.5 + 1} = 23 \text{ times}$$

as great as the method outlined and would call for still larger equipment capable of handling 7212 cfm per 1000 lb per hr.

At 250 F, the lower temperature limit, the dilution ratio η becomes $\eta = 25$, and the bag house is reduced to only 7.45 times as large as in the described method, to be capable of handling 2610 cfm per 1000 lb per hr. ▲

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ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building **Pittsburgh 22, Pa.**

Standardization of Lubricants for Steel Mills

by P. D. METZGER, Associate Research Engineer, Lubrication Testing Laboratory, and H. D. FOSTER, Standards Engineer, Wheeling Steel Corp., Wheeling, W. Va.

Wheeling's lubricant standardization program has given an overall savings of at least 10 per cent on large volume lubricants purchased on a yearly basis.

STANDARDIZATION of lubricants, whether for steel mill use or other, has one basic purpose; that is, to assure the proper quality of lubricant, to do the maximum number of jobs at a minimum cost. That minimum cost must take into consideration both application and maintenance costs.

How Wheeling Steel has progressed in the area of lubricant standardization is the subject for discussion. First, in order that we might have the same approach to the subject, let us briefly discuss standardization and give a definition for the often used and abused word "standard." For this purpose, a standard can be defined as a common solution, or solutions, to a recurrent problem. Also, very important in any one's approach to standardization should be the fact that standards are dynamic; better, they can be changed.

Some opposition is often encountered in the process of standardization. Many people hold to the erroneous concept that standards, once set up, are unchangeable. Some argue against standardization on the basis they want to reserve for themselves, the greatest latitude in the selection of products they use, in order that they might accrue the advantages of the most recent advancements in any given area. These same persons frequently are those who contend standards are not necessary, for they have used the same product for twenty years and it still works. How they reconcile these divergent approaches to a single problem must take some good mental manipulations.

These two frequent oppositions to standardization, misconception, and lethargy to change, are not too uncommon. The former can readily be overcome but the latter might take some doing.

Within Wheeling Steel's experiences in the standardization of lubricants, the above has not been the attitude. There has been considerable desire for improvement in the area of lubricants by the use of the standardization technique.

Originally, there were over 500 brand-name products used within the corporation, brand A doing the same job as brand B on similar applications in the same or different plants. This condition was alleviated by the first step in standardization as undertaken by Wheeling Steel; namely, simplification.

The products used were reviewed, and by agreement among the interested parties, many of those which were essentially the same as another were eliminated and one of the remaining group substituted. This elimination did not extend to the point where only one brand-name product in each lubricant class and viscosity range was in use, but only to the extent that there were ample brand names so as to afford a smaller multiple choice. There is still room for improvement but the standardization process to be discussed in detail will eliminate this condition, or at least lower it to the absolute minimum.

It was at this stage of advancement that the standardization of lubricants became more formal by the formation of a Standardization Sub-Committee for Lubricants. This subcommittee consists of a representative from each plant. These members are those persons who are directly responsible for lubrication in the plants; lubrication engineers, mechanical maintenance men, and a representative of the research laboratory; a well-rounded group in terms of knowledge and experience. This lubrication subcommittee is headed by the corporation's chief lubrication engineer.

Why all these people on one project? For two reasons, first and most obvious, the added knowledge and assistance attained by this setup; secondly, in order to satisfy the needs of the various plants, a simple means for discussion and decision of their problems and approaches thereto was needed, and is met by this subcommittee. Also to be recognized is the fact that by the participation of a representative in the standardization of lubricants, each plant will feel more compelled to use the finished product. The latter points out another feature of Wheeling Steel's standards, their use is voluntary.

The aforementioned partial simplification of brand-name products may suffice in some places or some industries as the maximum extent of lubricant standards. Most oil companies offer to check lubrication needs and come up with a very simplified list of products to meet these needs. Again, this might suffice for some, but it was agreed it would not completely suffice for Wheeling Steel. Simplification by brand name, where you have a special problem requiring a special lubricant, is an acceptable and economical solution. For other than special products, simplification by brand name would have burdened us with a fixed brand-name price, there is no opportunity for competitive bidding; in short, purchasing is throttled in the execution of their proper function. The possibility of excluding ourselves from other sources of supply in times of shortages or urgent need is also present. It might hinder use of an improved product put out by the usual supplier's competition. This limited simplification undertaken by Wheeling Steel is somewhat better than maximum simplification but it was felt that improvements could be made.

It was agreed by the subcommittee to set up a system of purchase specifications for those common lubricants used in many places and which represented a large cash outlay. This points up the fact that standardization of a lubricant, or any other item, where there is only

a single use, is seldom profitable.

In order to set up data to be included in the proposed specifications for lubricants, the oil companies' published specifications for their products were reviewed. The reasoning behind this step was to determine what was normally available in terms of physical properties.

The information provided was rather meager, some suppliers gave all the information you might need while others gave little more than viscosity. It was known from experience with many of the products which ones were satisfactory in what types of applications. That is, many products had been field tested and from this experience it would be possible to work backwards to laboratory figures which would have the highest degree of reliability.

Perhaps the primary requisite for the efficient standardization of lubricants by specification is the availability of a properly equipped lubricant testing laboratory. To test, verify and experiment, in order to set proper test limits for lubricants is a slow and costly procedure, even with the laboratory within your own corporation. An outside laboratory might be almost prohibitive in cost.

The test properties of each class lubricant were reviewed and correlated; in many instances these properties were verified in the research laboratory. For each class of lubricant, it is recognized that properties have varying degrees of importance; for example, to test for 2000-hr oxidation stability would be meaningless when talking about a red oil, the red oil is seldom in a piece of equipment nearly that long, much less under such severe condition as to require this test.

Each class of lubricant was reviewed by the subcommittee and limits for various tests determined, based on the experience attained through using a lubricant of the type under consideration. From what the lubrication men wanted, and what was available commercially, limits were set for each desired property.

Let us take a specific oil and review Wheeling Steel's approach to compiling its purchase specifications. One of the simplest oils in use in industry today is the red engine oil. A red engine oil is a straight mineral oil not too highly refined and used on lightly loaded bearings and machine elements. It is for once through application and in high leakage systems.

The later information defines the oil and its end use. This definition is of exceeding importance to Wheeling Steel and to any potential supplier; it is therefore included in the purchase specification under the heading of "scope."

The most important characteristic of this or any other oil is viscosity, the flowability of an oil at a given temperature. Wheeling Steel tests for the red engine oil viscosity at a temperature of 100 F and reports same in Saybolt Universal Seconds. Although viscosity can be measured by several methods, Wheeling Steel uses the Saybolt Viscosimeter, ASTM-D88, or more frequently the Cannon-Fenske Viscosimeters, ASTM-D445, and converts to SSU. The limits for this, and other qualification tests, appear in the purchase specification.

The maximum and minimum limits for the viscosity are taken directly from the Wheeling Steel Industrial Viscosity Classification for Lubricants.

It was agreed by the subcommittee that the viscosity index shall be a minimum of 0. The viscosity index is an empirical number indicating the effect of temperature on the viscosity of the oil. The viscosity index is calculated from the formula and tables expressed in ASTM-D567.

The limit set indicates that large viscosity changes can occur due to temperature fluctuations but this was not considered as of great importance in those applications requiring a red engine oil.

The flash point, as determined by Cleveland Open Cup, ASTM-D92, for this oil was set at 275 F, a level sufficiently high to satisfy our safety people as well as local and state regulations.

It was felt that for this type oil, operating conditions did not warrant concern over the fire since it would naturally be higher than the flash point.

The pour point of any oil is very important. The pour point limit for the red engine oil specification was set at +30 F. The members of the lubricants subcommittee felt that from their experience this limit was satisfactory, even though much mill equipment is located in unheated buildings. Additional experience might point out the necessity of lowering the pour point, either as a general requirement or by specifying naphthenic base oil for the special applications.

The limit for ASTM-D95, Test for Water in Petroleum Products, is zero. No water is wanted in this oil for the same reasons it is not wanted in other nonaqueous petroleum oils, it lowers the lubricating efficiency and may cause rusting.

The corrosive properties of this or any other lubricant is important. Oil components, such as corrosive sulphur, may adversely affect bearing elements should such a detrimental item be present. The limit for these corrosive properties, as determined by ASTM-D130, was set at No. 1b. This assures their absence.

Two tests, Saponification Number, ASTM-D939, and Neutralization Number, ASTM-D664, are primarily used as catch-alls or indicators. The neutralization number shows the absence or presence of total acids and is an indication of the degree of refinement. The combination of the neutralization and saponification numbers help to define the oil. The limit for the neutralization number is 0.10 and the limit for the saponification number is 0.5.

Three tests were listed in the completed specification and no limits were set; they were requested as a matter of record only. These tests cover color, ASTM-D155, carbon residue, ASTM-D189, and API gravity, ASTM-D287. These tests are requested for those times it will be desirable to identify a batch of the oil, the source of the crude or to calculate volumetric changes.

Add to the above those requirements on sampling, identification and packaging, and you have the completed purchase specification for a red engine oil as developed and used by Wheeling Steel Corp.

The red engine oil specification is a simple compilation of ASTM test procedures. Specifications for other oils require the use of more test procedures, ASTM tests, modified ASTM tests, and tests generally used by lubricant testing laboratories. In those instances where no ASTM or other common test procedure was available to test for a given characteristic, it was necessary to develop original tests.

To continue this idea of purchase specifications for red engine oils, an approved list of brand-name products has been issued against each purchase specification. All

products on this list were tested by the research laboratory to verify their compliance with the standard. It is planned that in the future an additional step will be taken in improving the list of approved products by grading each product and listing them in a preferential sequence. It should be pointed out that any oil meeting the specification will be of proper quality but that within the range of brand name approved products of any class there are varying degrees of quality.

One step which Wheeling Steel has taken in the use of their approved product listing might be called unique. Many companies use purchase specifications and listings of approved brand-name products. Their purchasing department buys any one of those brand-name products. The question develops, what about an oil, not branded, that is offered against this specification; will it be acceptable? At Wheeling Steel it is, and why not? If you purchase by specification against a brand-name list you are doing only half the job. You have many things on which to base this additional step, experience, accuracy of the limits set, the controls to check oils against these limits, and also the integrity of the supplier.

With the above information, the purchasing department has the maximum latitude in the execution of their function.

Specifications for the major classes of oils are now being completed. Sufficient background on the original specifications has been accumulated so as to say what value has been realized through this process.

The simplification accomplished by standardization diminished the variety of lubricants to the point where only one lubricant in each class and viscosity need be stored, that is the standard lubricant. Lubricants for which there are standards are identified by Wheeling Steel codes, not brand names.

Experience points out that an over-all savings of at least 10 per cent will be realized on most large volume lubricants purchased on a yearly basis. This small percentage represents a large savings when the total expenditure for volume lubricants is considered. This is the best kind of savings—money not spent.

Standardization of lubricants in the steel industry is slow, trying, and costly; but also it is one more thing—profitable.

Discussion

PRESENTED BY

W. H. MANDY,
The Texas Co.,
Pittsburgh, Pa.

P. D. METZGER, Associate Research Engineer, Lubrication Testing Laboratory, Wheeling Steel Corp., Wheeling, W. Va.

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A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

J. E. ANDERSON, Lubrication Engineer, Armco Steel Corp., Middletown, Ohio

H. D. FOSTER, Standards Engineer, Wheeling Steel Corp., Wheeling, W. Va.

R. J. BROSSMAN, Product Engineer, The Standard Oil Co. (Ohio) Cleveland, Ohio

C. T. LEWIS, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

W. H. Mandy: The first step in Wheeling Steel's standardization program, that of simplification or reduction in the number of products used, is highly desirable. There is, with few exceptions, a great opportunity in many steel mills to consolidate the lubricants in service. Our company has recognized this fact for some time and have inaugurated "simplified lubrication plans" in a number of industries— the primary purpose of which is to reduce to a minimum the number of lubricants recommended in their lubrication surveys.

One of the big problems that confronts a user of industrial lubricants today is the choice of a satisfactory product for a given application. How can he select from the vast number of products available, one or more which will do the job required? Wheeling Steel is attempting to accomplish this by setting up a system of purchase specifications for, as the authors put it, "those common lubricants used in many places and which represent a large cash outlay." I am not sure that I understand what is meant by "those common lubricants." If they have reference to the more simple type lubricants such as red engine oils, black oils, steam cylinder oils, and normal soap-oil type greases then procurement purchase specifications, defining certain basic physical properties or the initial suitability of the lubricant, can be set up based on their experience with certain brand-name products now in service in their mills. In deciding which basic physical properties are important the authors called attention to the desirability of including a definition of the lubricant and its use or the "scope" of the lubricant.

The initial suitability specifications drawn up for these, so-called, "common" lubricants should be specific enough and restrictive enough to satisfy the various applications, but not so much so as to limit the number of possible suppliers because this is the reverse of what is usually desired by the purchaser. Only those properties should be included which have an influence on the intended application. As the authors pointed out, viscosity for oils and penetration for greases will be a "must" for all specifications. Other properties included will depend upon the application. If the oil will be subjected to wide temperature variations in service, then viscosity index should be shown in the specification. Likewise if low temperatures are to be encountered, the pour point becomes a factor. The authors also pointed out that such properties as gravity, color and carbon residue have little or no significance in determining the initial suitability of the oil hence no limits should be set on these properties. The suppliers, however, should furnish the customer typical values on these properties because they are sometimes

valuable in checking the condition of the oil after it has been in service. To this list they should add flash point, neutralization and saponification numbers as being of little or no significance in determining the initial suitability of the oil.

There are many cases where purchase specifications for the simple types of lubricants have been successfully applied but, in many cases, the most highly refined mineral oils or the normal soap-oil type greases do not satisfy completely the requirements of a particular application. To meet this situation the refiners must give the lubricants special processing and treatment, and they must incorporate additives which will supplement or improve the natural properties of the lubricant. They must often be very selective in obtaining an oil from a certain crude source or which has undergone certain types of processing in order to be effective with certain types of additives or they must find additives which are effective with a particular base oil and compatible with other additives in the finished product. Lubricant manufacture has therefore been transformed from an art to a highly technical science.

It is impossible, in the writer's opinion, to adequately predict satisfactory performance data through simple laboratory tests which seems to be the usual method used when setting up purchase specifications. Several years ago a special subcommittee was appointed by the ASTM, Committee D-2 on Petroleum Products and Lubricants to prepare purchase specifications for lubricants. As a result of their studies, the committee reported that, "there is not enough reliable information now available as regards test methods to permit writing workable oil purchase specifications which would within themselves, without performance tests, serve as a reliable guide in the selection of lubricants." The best means of evaluating the performance characteristics of a particular product is to conduct a field test in the very equipment where the product will be used. Almost everyone, purchaser and supplier alike, will agree on this point but the procedure frequently is time-consuming and usually presents certain inconveniences. Attempts are made to obtain the same information by the use of accelerated laboratory tests or other special tests designed to simulate operating conditions. It is in this regard—predicting product performance or evaluating one product against another by simple laboratory tests—that the supplier and the purchaser fail to see eye to eye.

We believe the purchaser of lubricants can be assured of obtaining products which will satisfy his requirements best by discussing the standards of performance expected with the supplier.

P. D. Metzger: Common lubricants are those lubricants that represent a large volume or a large cash outlay. We are not limiting ourselves to red engine oil but are using red engine oil as an example. We chose to talk about red engine oil because it is one of the "large volume" items and because the specification requirements for red engine oil are "basic" to most all other types of oils.

Mr. Mandy expressed the fear that "standardization" will limit the number of our suppliers. We do not feel this way. We feel that we are "opening the door" to more suppliers, that is more suppliers will have a chance to bid for our business for they will be competing on the basis of a specification and not a "brand" name reputation.

We also realize that laboratory bench tests in themselves do not predict plant performance, and especially do we agree that a single test as a neutralization number, a saponification number, etc., is in anyway meaningful. Further we do believe that the results of a series of tests made on an unknown oil compared with the results obtained with the same tests made on an oil having performance background would at least be indicative of what might be expected of the unknown oil.

W. H. Mandy: Restrictive specifications tend to limit potential suppliers. We do not know how restrictive you will be or how wide open the gate will be. It is difficult to write specifications which adequately describe the product desired without making them so restrictive that only one crude source could be used in the manufacture of the product. In such cases you would be limiting suppliers to those who had the particular crude source.

P. D. Metzger: What you say is true. Such a danger does exist in writing specifications and we are trying to guard against such a situation. Of course we can make mistakes but standardization specifications are dynamic and we will change ours quickly in the event they become restrictive.

J. D. Lykins: We would not build a specification around any one product for any one application.

To begin with, when developing a specification, we consider the application, go over what are the most important requirements involved. Then the laboratory establishes limits for these requirements by testing products which have given good field service. That is the limits are based on products with many years of field service behind them. As a rule, we would not limit our specifications to any one producer or any particular product.

A. E. Cichelli: Do your field conditions determine the specifications you establish in the laboratory? In other words, do you attempt to correlate field performance within certain limits?

J. D. Lykins: Yes, for the common requirements such as viscosity power, etc., there is no trouble for there is a common test that all agree on. For special requirements as in the case of circulating, backup roll bearing oil where water separation is an important factor, we have had to develop a special test. Most all the suppliers can furnish an oil at their refinery with a 1620 emulsion number but when one receives this oil at his plant it is no longer 1620. The steam emulsion and other available emulsion tests were not meaningful to us so we developed a test which gave the conditions that were encountered in the field. In other words, if a condition occurs that cannot be evaluated to our satisfaction with a regular ASTM test, an attempt is made to develop our own test. We were also the first people to incorporate the addition of water to the grease in the shell roller test. This was brought about by a plant condition where water entered the work roll bearing on a hot strip mill. We will now establish limits for the grease penetration after it has been worked in the shell roller in the presence of water. These limits will be established on the basis of work with commercially produced and marketed greases.

J. E. Anderson: Occasionally, in checking the performance of a lubricant in a plant, the reported performance seems to relate more closely to the colors on the drum than to the lubricant which is inside. The establishment of user's specifications, and shipment in unmarked drums, should eliminate such misleading reports.

The authors' conclusion that the use of brand-named lubricants throttles the purchasing function seems somewhat harsh. All nonspecialty brand-named lubricants can be closely approximated by any of several suppliers. If one is confronted with a fixed brand name price, and that price is too high, a change in brand-names is in order. Such a change may be difficult to arrange in the face of the "lethargy to change" mentioned by the authors, but with persistance it can be done. Some spirited purchasing action has been experienced in our company, even with the use of brand names.

1. Do you use the standardization subcommittee arrangement for other expensive maintenance items, for example refractories, steel mill rolls or others?
2. How do you use your lubricant testing laboratory to test incoming shipments? Do you sample each incoming tank-truck or railroad tank car? How do you sample shipments of drums?

H. D. Foster: On the use of standardization subcommittee arrangement for other expensive maintenance items, for example refractories, steel mill rolls, etc., we are working in other fields that we find to be very costly. Coincidentally we are currently conducting a survey of rolls, work rolls in particular. The program is well along in the area of maintenance painting not only in terms of quality of paints, but also in terms of methods of application.

P. D. Metzger: The lubricant testing laboratory has for sometime now been testing incoming shipments of process oils to check these oils against the suppliers specifications. This of course will continue and be expanded under the "standardization program" for lubricants as the need dictates. At this time, a sampling schedule or program has not been established but I can say on the basis of some of the discussions, each incoming tank truck or tank car delivery will be sampled and it is thought that different lots or multiples of lots of drum shipments will be sampled. With this information backed by periodical "plant samples," we should be able to develop a history of the lubricant which would prove or disprove our specification requirements.

R. J. Brossman: A question on the extent of effective specification buying, deals particularly with the continued performance values of products which are purchased on this basis from little known suppliers. The law of diminishing returns comes into play insofar as both the consumer and supplier are concerned, directly affecting the economic interests of both parties. Therefore, in some instances it behooves the consumer to rely upon the integrity of the supplier for initial and continued application of quality products and attendant services. Generally speaking, the "cat and dog" type of supplier cannot or does not maintain quality control and is not in a position to provide services on a basis comparable to larger companies having greater facilities and experience at their disposal. Therefore, specification buying has certain pitfalls involving periodic checking of quality materials from this type of supplier.

P. D. Metzger: This will not occur because we are not looking. If, a company comes in with a lubricant that meets our specification, at a very attractive price, and we know very little about this company, we would certainly not buy 14 carloads of oil from them on the basis of a few laboratory tests. By the same token we would not turn our backs on the company, and if he were favored we would hope to follow his products as we would any oil company.

R. J. Brossman: It is the integrity of the company we are thinking of and what their words mean as far as continuing to supply quality or product which will continue to meet the specifications and provide the performance which the consumer and supplier have agreed upon.

H. D. Foster: With a brand name oil supplied against the specifications, the supplier has certain obligations and responsibilities. These they are guaranteeing when they brand name that oil. This we are most inclined to accept, i.e., the integrity of the supplier.

Should supplier X come in and say "this is as good as oil SWY, and therefore, use it instead," we will first test it to be sure that this is comparable to oil SWY and perhaps we will use it. The next time he comes in and says his oil is still the same, it is just as good as SWY, we may accept his word, but if it proves to be otherwise, it will be rejected. Included with the tests are some miscellaneous items at the end of the specifications.

One of these items requires that the materials which fail to meet the specifications shall be removed by the supplier and the supplier is subject to all expenses incurred by such failure. We do though from time to time test all products received.

C. T. Lewis: The authors list various ASTM test references to other specification tests, one was a demulsibility of fluids test.

Would you care to enlarge on that method? There are many people, consumers, suppliers, purchasing agents and others who are interested in the demulsibility because so many times you get an oil that satisfies, as received, but when you put it in use for even 24 hours, the test fails.

P. D. Metzger: The demulsibility test as developed in the Wheeling Steel research laboratory consists of a means of thoroughly mixing a predetermined volume of water and oil, maintaining this mixture at a constant temperature (180 F) for a period of five hours, and during this time samples of the mixture are withdrawn to study and determine the ability of the oil to shed the water present in the mixture. An additional settling time at room temperature for a period of approximately 19 hr is continued after the 5-hr, 180 F settling time to allow further water and/or emulsion to separate from the oil.

At this time we have only worked with straight mineral oils having a "Steam Emulsion Number" of 1620 but have found some of these oils to have poor demulsibility characteristics and others to have good demulsibility characteristics. The present plan calls for an investigation of R & O (rust and oxidation) inhibited oils and then EP (extreme pressure) oils. ▲

Hard surfacing of blast furnace bells and hoppers offers a promise of eliminating a major blast furnace repair during campaigns . . . . in addition, procedure may be necessary for operation of the blast furnace under high top pressures and harder burden materials.

Hard Surfacing of Blast Furnace Bells and Hoppers

by ROGER FLUCK, Assistant Superintendent, Weldment Dept.,
and CHARLES W. DUNN, Welding Supervisor, Bethlehem Steel Co., Bethlehem, Pa.

HARD surfacing of blast furnace bells and hoppers is a current problem which has aroused considerable interest by all persons connected with the steel industry. In an effort to cover the subject in its entirety, this paper includes a brief history of past practices, the present program as set up by the Bethlehem Steel Co., and suggested future developments to attain a most economical and efficient operation.

Blast furnace bells and hoppers have always been made as steel castings of various analyses. Repair and maintenance of these castings has cost the steel industry a great deal of time and money. With the use of higher operating top pressures, it is recognized that something has to be done to increase the life of bells and hoppers and afford a more positive seal at the seating surfaces. New burden materials being constantly used seem to cause greater wear on most of the surface area. Recent reports from visits to foreign countries have disclosed the fact that in some cases other people are further advanced on this subject than we are here in the United States. For example, reports indicate that Russia has been using very high top pressures in their furnaces and has been using numerous hard surfacing alloys for welding on bells and hoppers.

It costs our company approximately a quarter of a million dollars to change a bell and hopper during a campaign. This high cost gives the welding engineer a lot of latitude in the selection and method of hard facing. It is felt that under operating conditions as they now exist, a hard-faced bell and hopper can last the full campaign regardless of the burden. With the use of higher top pressures, this may not be the case at present, but future developments could prove this a reality.

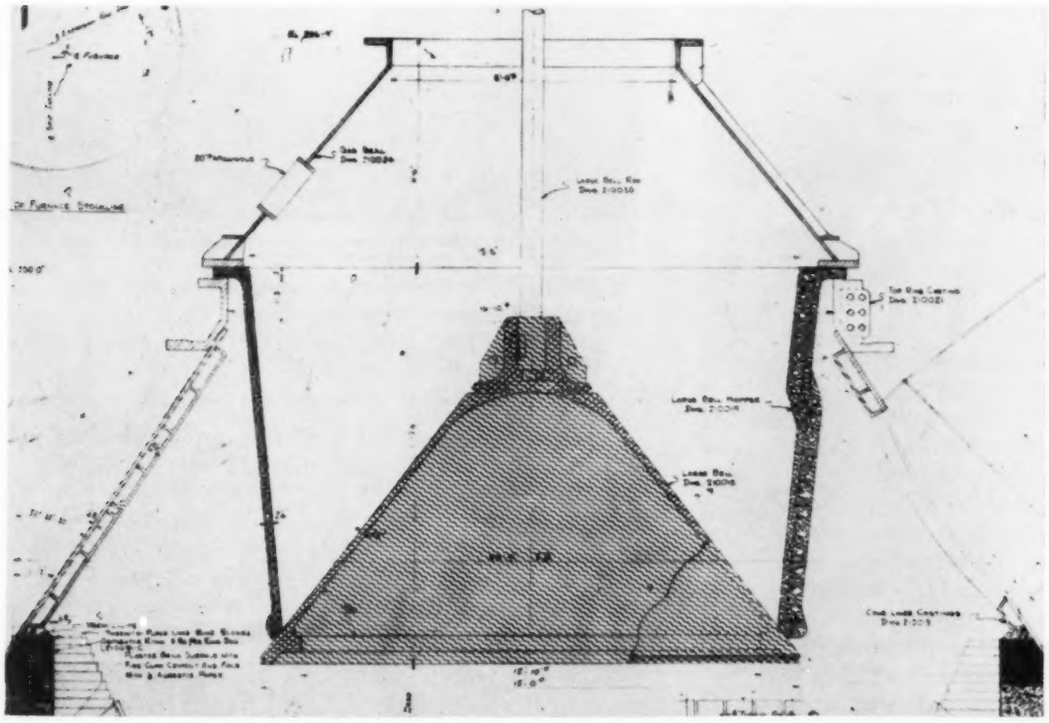


Figure 1—Typical arrangement of large bell and hopper assembly.

Other methods, excluding welding, may be the answer. Some of the methods are as follows:

1. Up to now bells and hoppers have been cast with AISI—1730 analysis. This could be changed to other grades more resistant to wear and corrosion.
2. It is understood that some steel mills have tried wrapper plates of manganese steel. The success of their use is unknown to us.
3. Basic design changes to a furnace are also under consideration.

The first attempts at hard surfacing were rather crude in comparison with today's modern methods. For many years, welding has played an important part in repairing defects and covering up porosity which sometimes is apparent after rough machining the castings. This welding was all done with manual electrodes with little or no thought toward hardfacing overlays.

The first indication of hard surfacing occurred about seven years ago when a customer requested a cast steel bell with two bands of weld on the seating area. Each band was undercut ¼ in. deep by 2 in. wide. The two grooves were filled in with allowance for machining using manual electrodes of a nickel base alloy. The bell was preheated to a temperature of 250 F. Although the resultant weld deposit was rather rough, it cleaned up satisfactorily during final machining. Since this bell was for use in a foreign country, no service life is known.

The next attempt at hard surfacing occurred about one year later when it was decided to recondition an old bell which was in very poor condition. All the bad areas were scarfed out and manually repaired, after which the entire seating surface was covered with a type 420 stainless steel weld deposit. The bell was mounted on a 16-foot vertical boring mill with the apex upright. A semi-automatic submerged arc welding unit was mounted on the tool post, and the welding performed as the boring mill rotated. The bell was preheated to 250 F and the resultant weld showed numerous cracks. The weld deposit was too hard to machine and had to be ground.

Some time later, another bell was hard surfaced on the seating area. The bell was set on blocks, preheated to 250 F and block welded manually. A total of four welders were used working 90 degrees apart in order to minimize distortion. Each block was numbered to show the sequence of welding. A total of 1550 lb of a nickel-base alloy was consumed at the rate of three lb per hr for each welder.

Shortly thereafter, the thought of a fully automatic operation was conceived. Many informal discussions were held with vendors of positioning equipment, automatic welding machines and welding electrodes. After thoroughly studying the problem, it was concluded that such a program was very feasible. Decisions had to be made as to where the work should be done, how it should be done, and what welding process was to be used.

It was concluded that different types of alloy welding materials should be used on the seating surfaces and the burden areas of bells and hoppers. Since many alloy materials and processes are now available, it was difficult to pick one which was outstanding for the service required. After much experimentation and testing for all properties desired, it was decided to use materials of the following percentage analyses:

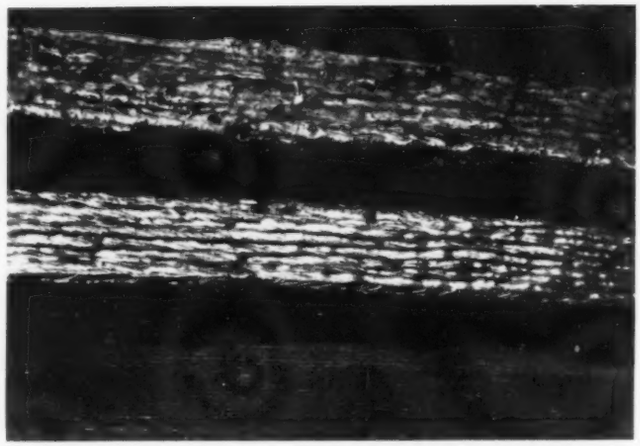


Figure 2—Manual weld beads are deposited on seating area.

Figure 3—Manual weld beads are shown after machining.

Figure 4—Finished bell has two welded bands on seat.

Seating area:

Cr	W	Fe	C	Co	Mo	Ni
15.5	3.4	5.5	0.11	1.92	16.0	Bal

This material has a deposited hardness of Rockwell C22, is readily machinable, and can be work hardened to Rockwell C40.

Burden area:

Cr	C	Mn	Fe
12.0	1.0	4.0	Bal

This material has a deposited hardness of Rockwell C28, is not readily machinable, and can be work hardened to Rockwell C45.

The hard surfacing of two, three or four-piece hoppers presents a rather difficult problem. There are many existing sectional hoppers which may require hard surfacing. To do this, the sections could be welded as a unit, broken at the joints, rectified and reassembled for final machining. It is contended that a preferable method would be to cut off approximately two feet around the bottom of each section and then cast or fabricate a solid ring to be used for the bottom or seat of the hopper. Horizontal flanges could be welded to the sectional pieces for bolting to the solid ring. All new hoppers are designed to include a solid cast steel ring for the bottom section. This does not present any particular hardship for the hard surfacing operation.

To do a good job of hard facing, we must have a good clean and sound casting. A study was made by our foundry, changes made, and as a result, the castings are exceptionally clean and sound. After a bell and hopper are cast, the risers and gates are burned off, sand blasted and then given a visual inspection. Any defects are scarfed out and repairs are made in the green state. After the visual inspection, the casting is given a spot magnetic particle inspection around the lugs, handles and gate sections. At this point, the casting is sent to the anneal where the furnace temperature is raised 50 F per hour until it reaches 1675 F. It is held at this temperature for 12 hr and furnace cooled to 600 F. From the anneal, the casting is shipped to the machine shop.

At the machine shop, the bell is set up to suit the best conditions. The bells are set apex down on a vertical boring mill and checked. Then the rough machining is begun for approximately half the length of the taper. The bottom is then faced and the undercutting of the seat is completed. The bell is then turned around and set up to the machined surfaces at which point the balance of the taper is cut, the apex is rough machined, and a setup band just above the apex is completed. The bell is then shipped to the weldment department for hard facing.

In order to effectively weld all sizes of bells and hoppers which are used throughout the Bethlehem Steel Co. and possibly the industry, a thorough engineering study was made of the equipment required and the best location for the complete welding operation. Numerous vendors were contacted with whom the welding problems were discussed. All propositions were thoroughly studied with the result that the equipment purchased satisfied our requirements on a most economical basis.

The location of this welding equipment involved considerable study since many operations are involved in the complete fabrication of hard surfaced bells and hoppers. It was finally decided to locate the equipment in an 80 ft wide by 300 ft long bay of the weldment department of the Bethlehem plant. This shop provided ample space, head room, crane capacity. It had existing power lines and gas mains conveniently located with a minimum expense involved for tie-in service. Furthermore, the personnel of this department has had the most extensive experience in all phases of welding.

The welding positioner has a capacity of 350,000 lb at 12-in. center of gravity from the face plate or 107,000 lb at 72 in. center of gravity from the face plate. It is capable of rotating 350,000 lb at 6 in. eccentricity which is equivalent to a torque load of approximately 2,000,000 lb-in. It has a variable rotation speed range of

Figure 5—A semi-automatic application is made of hard surfacing on bell.

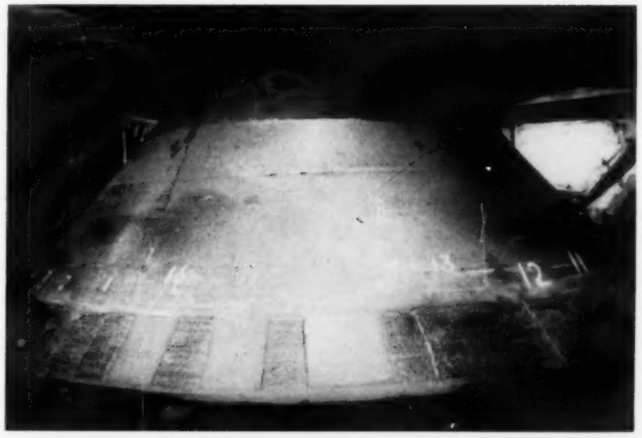


Figure 6—Block welding technique is used on seat of bell.

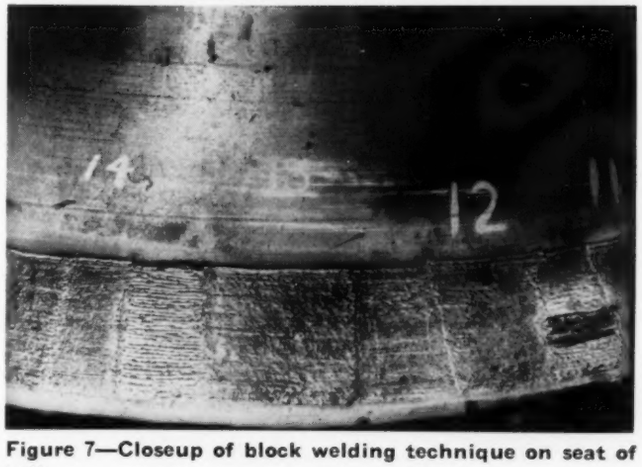


Figure 7—Closeup of block welding technique on seat of bell.

Figure 8—A manual weld bead is put on hopper seat.

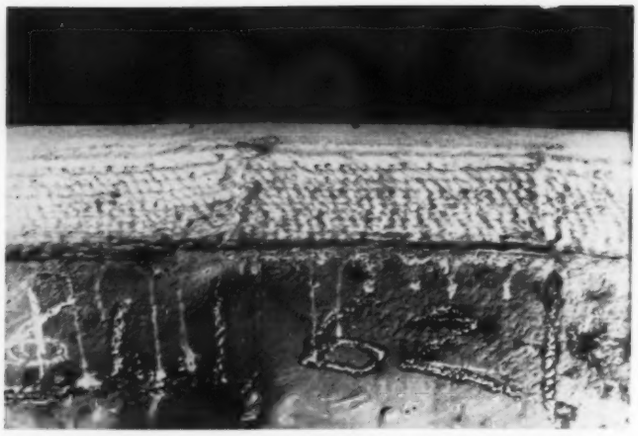


Figure 9—Closeup of manual weld bead on hopper seat.

0.013 to 0.40 rpm. The tilt ranges from vertical to a back angle of 45 degrees or a total of 135 degrees. The tilt speed requires 2.5 min to travel 90 degrees. The table of the positioner is 10 x 10 ft with radial and transverse slots in which are located square nuts for bolt mounting in various positions. The over-all height of the positioner with table horizontal is 102½ in. Total weight of positioner is approximately 50,000 lb.

The welding manipulator consists chiefly of a circular base, a mast and a traveling boom. The base is permanently anchored to the foundation and has a large circular gear ring which is stationary. At the bottom of the mast is mounted a motor and gear pinion which engages in the gear ring permitting 360 degrees rotation of the mast. A plate extends out from the base of the mast on which is mounted four 600-amp, a-c/d-c motor-generator welding machines, a large flux recovery vacuum unit and the main electrical panel. On the mast is mounted a heavy-duty motor-operated link chain which raises and lowers the boom. The top of the mast is 27 ft-6 in. from the floor line. A ladder is attached the full length of the mast to afford easy access to the boom at any elevation.

On the boom is mounted a gear rack, guides and rollers and a motor with pinion gear to afford variable speed travel of the boom in a horizontal direction. On top of the boom is a full length catwalk and railing to permit accessible working space for operators. Two automatic submerged-arc welding heads, two flux hoppers and welding-wire reels are located at the end of the boom. The welding heads can be spaced from 4 to 30 in. apart in a direction parallel to the axis of the boom. Each head has vertical and side adjustments for accurate positioning over the work. The two flux hoppers are part of an enclosed flux-recovery system. One hopper is used almost continuously and is fed from the unfused flux picked up behind the welding zone. The reserve hopper is used only when the supply is depleted in the main hopper and until this supply is replenished. A control panel is mounted approximately six feet behind the welding heads. On this panel are all the various control buttons with indicating lights for all motions of the equipment and electrical controls of the welding heads. Separate control buttons are also mounted at convenient locations on the positioner and the manipulator.

Both the positioner and the manipulator are mounted on a common reinforced concrete foundation. The positioner is elevated 30 in. from the floor line to permit

Figure 10—A 5-piece hopper is assembled.

Figure 11—Positioner and manipulator for hard surfacing bells and hoppers have 250,000-lb capacity.

rotation of pieces up to 20 ft in diameter. All power lines feeding these units as well as the welding equipment are located in underground conduits. All main switch boxes are conveniently located on a nearby wall.

Requirements for preheating bells and hoppers prior to welding necessitated the installation of natural gas feeder lines to supply ample gas. These feeders are located on a wall directly behind the positioner and five permanent lines were run to the back of the positioner. From this point, flexible lines carry the gas to the underside of the large center bearing. A 14-in. hole in the hollow spindle inside the center bearing provides access for feeding gas to the burners which are located inside the bells and hoppers. By means of a special mounting device, these burners remain stationary as the positioner revolves.

Up to the present time, three bells and two solid hopper rings have been hard surfaced. The first bell to be welded was an old bell made of 0.50 per cent carbon steel. Due to the high carbon steel, it was decided to use a minimum preheat of 500 F. Special mounting lugs were first welded to the inside of the bell. Eight radial spokes fabricated from 10-in. channels were bolted to the face plate of the positioner. The bell was then set on these channels and by means of special long bolts, it was secured to the channel spokes on the positioner. After tilting the table just enough to allow sufficient air to support combustion, the preheat burner ring was ignited and the bell rotated. The initial attempt to uniformly preheat the bell required too much time. Consequently, the orifices in the special burners were opened up to supply more gas to the ring burners. This permitted attaining a preheat of 500 F in eight hours. Temperature measurements were made and recorded at periodic intervals.

Since the seating area required 18 in. of weld deposit, the two heads were set 9 in. apart and welding with both heads commenced simultaneously. The welding wire used was a $^{3}/_{16}$ in. diam. nickel-base, machinable alloy. The welding conditions used were approximately 425 amp at 30 volts and a surface speed of 20 in. per min. Four beads per inch were deposited as complete rings. After the completion of each revolution, a special time relay step-over device moved the entire boom $^{1}/_{4}$ in. to allow continuous welding of successive rings. Upon completion of the first layer, several conditions existed which caused some bad areas of welding. It was discovered that the drive pinion was not properly engaging in the gear rack on the boom, thus causing irregular step-over from one bead to another. The speed of 20 in. per min appeared to be too slow for the fluidity of the weld metal and was subsequently changed to 29 in. per min. Too great an off-center distance also caused some irregular welding.

After removing a considerable amount of defective weld by arc-air gouging, the low areas were manually welded. The second layer on the seating area was deposited without any trouble. The burden area of the bell required a weld deposit approximately 60 in. long. This length was determined by establishing a vertical line from the outside diameter of the small bell to a contact point on the large bell and adding four more

Figure 12—Control panel is feature of equipment.

Figure 13—Preheat burners are applied to inside of bell.

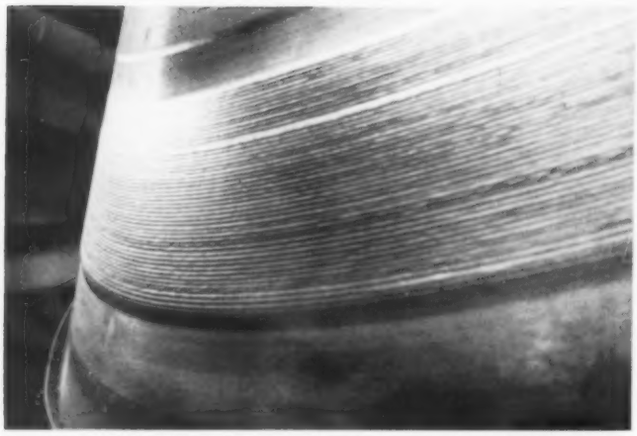


Figure 14—Weld bead surface is shown as deposited on bell.

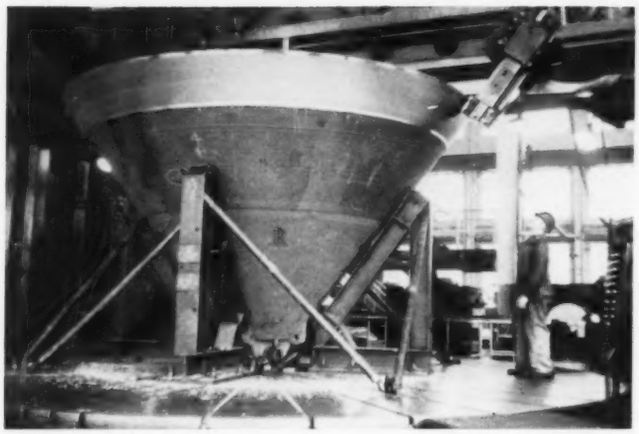


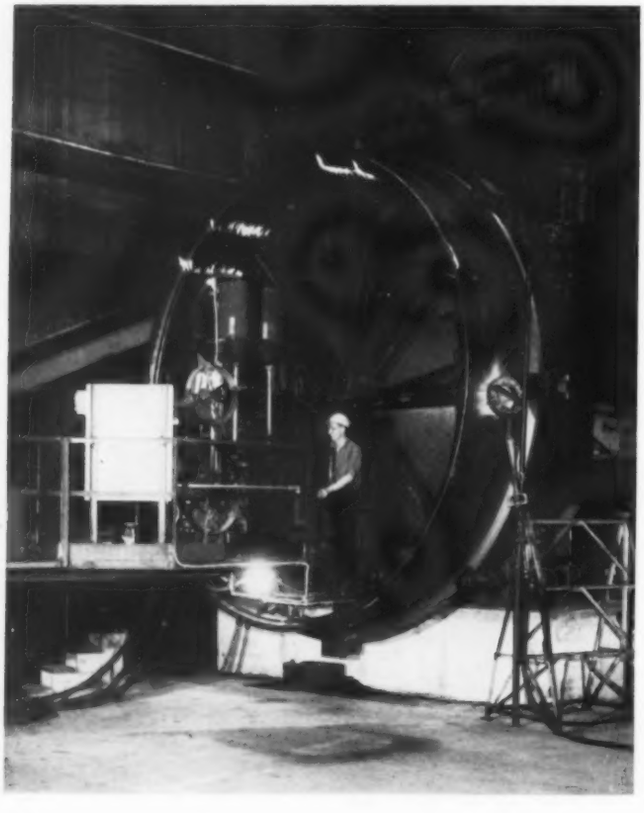
Figure 16—Seating surface is being machined after welding.

inches. Two layers of nonmachinable medium-chrome-iron weld material was deposited without any trouble.

After stress relieving, machining of the seating surface commenced. After several cuts had been made, it was noticed that considerable distortion had taken place, so that in order to clean up the entire surface, some areas would not have enough weld deposit. In an effort to salvage the work already completed, it was decided to manually weld the low areas which were 180 degrees apart. After depositing about 50 lb of manual weld, the bell was put back on the horizontal boring mill. Indications showed that the manual welding performed had aggravated the distortion. It was then decided to true-up the entire seating surface and send the bell back for rewelding. The second weld deposit proved successful.

During each welding operation, deposition rates of 18 lb per hr for each welding head were attained. The first welding operation required 1125 lb of wire on the seating area and 1145 lb on the burden area. The overall time consumed amounted to 213 manhours, resulting in a deposition rate of 10.6 lb per manhour. During the second or reweld operation, 1365 lb of wire were consumed, using 81.5 manhours giving a deposition rate of 16.8 lb per manhour.

Figure 15—Welding is being done on a hopper ring.



The second and third bells which were welded were newly cast to specifications as previously mentioned. Due to lower carbon content of the cast steel, a lower preheat of 400 F was used. Both of these bells were welded, treated, and machined without any difficulty.

On the second bell, a total of 2911 lb of wire was consumed using 215 manhours, resulting in a deposition rate of 13.5 lb per manhour. Figures for the third bell were 2400 lb of wire, 190.5 manhours and a deposition rate of 12.6 lb per manhour.

The two hopper rings which have been hard surfaced presented no problems and both were finish machined satisfactorily. These hopper rings are a one-piece casting and will eventually bolt on to four 90 degree castings to form a complete hopper. The nickel-base alloy was deposited on the seating surfaces, and the medium-chrome-iron material was deposited on the bottom edge and part way up the inside of the hopper.

A total of 1817 lb of wire was consumed on these two rings, using 208 manhours. The lower deposition rate of 8.7 lb per manhour was due to the fact that only one welding head could be used for a considerable portion of the operation.

All bells and hoppers were slow cooled on the welding positioner by backfiring of the burners. After cooling to room temperature all welded lugs were burned off the castings and they were then transferred to the treatment department. All pieces except the largest size bell, which measures 16 ft-6 in. diam., could be transferred on an inter-shop buggy to the treatment department. The large bells are transferred on a special truck. Here a large 20 x 20 ft carbottom furnace is available which permits setting all bells and hoppers upright on the furnace car. Stress relieving included a 10-hr hold at 1100 to 1150 F and furnace cool at 50 degrees per hr to 600 F. Midway in this heating cycle, the castings were rotated 90 degrees to minimize distortion.

Upon completion of the treatment cycle, the hard-surfaced bells and hoppers were sent to one of the larger machine shops. A 25 ft vertical boring mill has ample capacity to accommodate all machining operations. On

Figure 17—Seating surface is pressure rolled after machining.

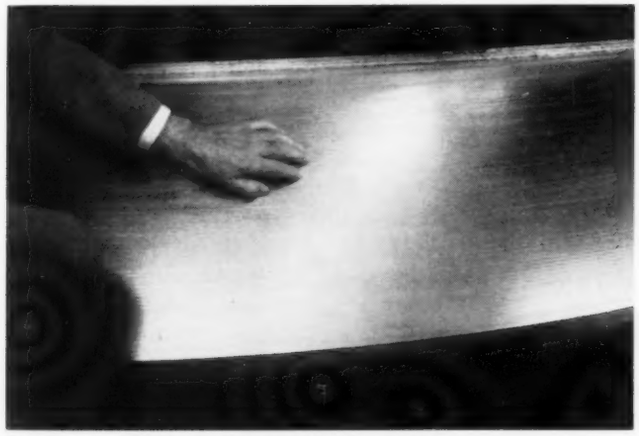


Figure 18—Closeup shows rolled surface.

some of the experimental test pieces, feeds and speeds were established which proved successful on the final machining operation.

Since the weld material as deposited is not very hard, some method had to be devised to work harden the finish-machined seating surfaces. A special rolling tool was designed and numerous studies were made on experimental pieces to determine the proper surface contact area and pressure to be used to attain maximum hardness. This tool was mounted on one head of the large boring mill and the complete seating area work-hardened to 400 Brinell.

After final machining of the bells and hoppers, the bells are balanced and fitted into the hoppers. The specifications require that the pieces must fit together with a maximum opening of 0.006 in. So far it has been possible to maintain a fit within 0.004 in.

Since the life of blast furnace bells and hoppers must be increased to accommodate higher top pressures and harder burden materials, much development work remains to be done. Other welding materials, processes, and techniques must be tried to prove relative merits. Redesign of castings or plate fabricated bells and hoppers could help to improve the service life. Since the time involved in what is to be considered a good life of a bell or hopper is of considerable length, it is hoped that a concerted, co-operative effort will be made by all persons in the industry to share with each other their development work.

Discussion

PRESENTED BY

FRANK GAYDOS, General Foreman, Weld Shop, Gary Steel Works, United States Steel Corp., Gary, Ind.,

CHARLES W. DUNN, Welding Supervisor, Bethlehem Steel Co., Bethlehem, Pa.

I. W. EVANS, Chief Engineer-Cranes, The Morgan Engineering Co., Alliance, Ohio

DAVID WOOD, Woodson Products, Detroit, Mich.

Frank Gaydos: Is a 1650 F full anneal necessary?

Charles W. Dunn: The metallurgical specifications department says that all heavy castings will be given a 1650 F full anneal as standard practice.

Frank Gaydos: Have you faced any small bells?

Charles W. Dunn: The Bethlehem plant has not faced any small bells as yet; however, the Johnstown plant did face a small bell using 420 stainless. Eventually, it is intended to overlay all small bells, but we have not decided whether or not to use the submerged-arc or the inert-arc process.

Frank Gaydos: What determines your selection of a work-hardening alloy over the hard-as-deposited facings?

Charles W. Dunn: The decision is based upon precedent. A survey of the blast furnace industry shows up until this writing, 99 per cent of the bells had been hard faced using work-hardening types of deposits. Currently studies are being made of the hard-as-deposited and the precipitation type alloys.

I. W. Evans: What are the properties of the materials you are now using that makes them more favorable than other materials which you have tried, and was the seating area free of checking?

Charles W. Dunn: Part of this question was answered in the previous discussion. The nickel-base alloys consistently gave us a crack-free deposit, whereas, the iron-base alloys would not always give us a crack-free, porosity-free deposit. Through experimental work it was found that the nickel-base material could be depended upon to give a crack-free deposit up to a minimum of three layers.

I. W. Evans: What are the minimum number of

layers determined necessary on the seating area?

Charles W. Dunn: It is desirable to stay away from the word layers when referring to a blast furnace bell. Instead, it is better to set a minimum depth of deposit. A three-layer deposit will clean up with a minimum of $\frac{3}{16}$ in. finish surface.

I. W. Evans: What do you consider a necessary finish?

Charles W. Dunn: All seating surface are burnished for work hardening the alloy, and this results in the equivalent of a 125 to 63 microinch finish.

I. W. Evans: Have you determined a procedure that eliminates the distortion you encountered?

Charles W. Dunn: Using proper precautions for preheating, uniform heating can be obtained with little or no distortion. Gas pipes come up through the hollow spindle of the positioner. Special burners were made up for bells and also for the hoppers. Preheat temperatures are raised 25 to 50 F per hr and held at temperature for a predetermined time to allow a thorough soak. The bell must be tipped to allow enough air for combustion to take place. Once the burners are lit, the bell or hopper is continually rotated until the welding starts. At present, the target is a 400 F preheat, this being checked every hour by a foreman of the shop, until the job is completed.

I. W. Evans: What major differences, in procedure, would you recommend to recondition a used bell and hopper?

Charles W. Dunn: This question is quite complicated and up to this writing we have not reconditioned a used bell and hopper. A tentative procedure setup for a used bell and hopper would be as follows:

1. It will be stress relieved.
2. Machined to give a true diameter.
3. Inspected by the magnetic particle principle.
4. Low spots and lateral grooves will be manually welded.
5. Circumferential grooves will be submerged-arc welded.
6. Then a minimum of one layer of build-up material will be applied to both seating and burden area.

From this point on it will be treated as any other bell and hopper.

We do not advocate reconditioning old sectional hoppers, but would encourage cutting off the bottom portion and welding on flanges to allow for bolting a new cast or fabricated ring.

David Wood: Are the hoppers preheated prior to welding and how is this accomplished on the rotating positioner?

Charles W. Dunn: Gas pipes come up through the center of the spindle of the positioner to special burners for preheating the hoppers. The hopper is tilted the full 90 degrees of the positioner; the burners are lit and the piece rotated and checked in the same way as mentioned for the bells. In all cases, the burners are stationary and the pieces rotate around the burners. ▲

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Making Lubrication More Effective As A Weapon In Management's War On Wear

by WAYNE G. RITTER,
President,
Ritter Engineering Co.,
Pittsburgh, Pa.

. . . . more savings are possible in changing method of lubricant application than in changing lubricant . . . . more important, however, is that good lubrication practice can save a far greater amount in machinery cost and reduced delay time . . . .

TODAY, it costs more to produce steel than ever before in the history of the industry. Cost of labor, cost of purchased goods and services, interest charges on long term debt, depreciation charges and the cost of new plants and equipment are at all time highs. There appears to be little prospect that this upward trend, toward higher and higher production costs, will be reversed. With these ever increasing costs, there is more than ever an impetus to prolong the life of steel producing equipment by making efforts to slow down wear rates, and instituting preventive maintenance measures to avoid equipment breakdowns.

Fewer and fewer workers are producing more and more steel. Machinery is becoming more complex and more automated resulting in higher and higher maintenance costs. This rising trend can be shown by the curve (Figure 1) derived from operating cost data of the nine largest steel companies in the United States:

The curve is based upon the data of Table I.

The total cost of repair and maintenance (R & M) in 1957 for the nine companies was $1,463,400,000. These costs, unlike the negotiated wage rates, can be attacked and reduced by understanding the basic causes for wear and by making concentrated efforts toward reducing rate of wear. If only a 10 per cent reduction in over-all R & M costs is realized through such efforts, a considerable sum can be added to corporate profits without inflationary price increases. For example, in 1957 such a reduction would have added $146,000,000

Figure 1 — Chart shows trend in repair and maintenance expenditures compared with total manufacturing cost averaged from nine steel plants.

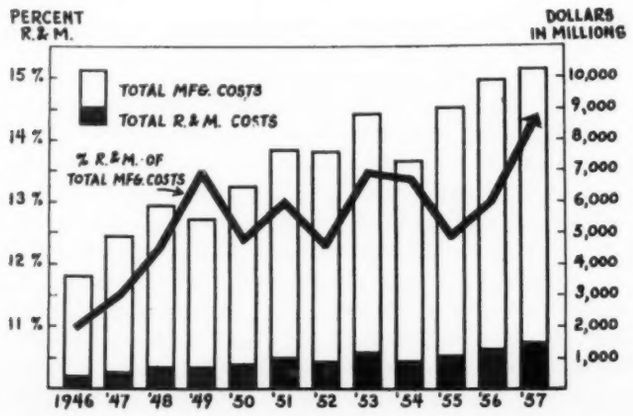


TABLE I*

Repair and Maintenance Expenditures vs Total Manufacturing Costs (Nine Largest Steel Companies)

Years	Total manufacturing cost, millions	Repairs and maintenance, millions	Per cent repair and maintenance of total manufacturing cost
1946	$ 3633.1	$ 400.0	11.0
47	4930.8	568.5	11.5
48	5918.4	727.4	12.3
49	5404.3	727.5	13.5
1950	6488.6	807.1	12.4
51	7773.6	1012.7	13.0
52	7636.9	936.0	12.3
53	8868.0	1195.5	13.5
54	7381.6	953.6	12.9
1955	9045.7	1119.9	12.4
56	9916.6	1288.0	13.0
57	10241.6	1463.4	14.3
12-Year totals:	$87,239.2	$11,199.6	12.8

* Source: Securities and Exchange Commission Statements.

to profits of the nine companies.

As soon as a piece of machinery is designed, built, installed and placed in operation it starts to wear out. Everything possible will be done to get the rated tonnage—and then some. Lubrication then becomes the principle means of prolonging machine life expectancy and efficiency of operation.

If a machine completely wears out, the problem of replacement with new facilities confronts management. Here the problem is lack of adequate funds to do the job. With the Engineering News Record Construction Index at 808.48 (1946: 368.46; 1901: 100), there is a real problem for management. Therefore, it is of utmost importance that rate of wear be minimized—and the principle weapon, one which can do 75 per cent of the job, is *good lubrication.*

Centralized grease and oil systems have been available to the steel industry for over 25 years. Now it is an established fact that these systems are desirable and effect economies in operation. Virtually all specifications for new production facilities include provisions for lubrication devices. Centralized systems are doing a good job—but they are not doing it good enough. Experiences over the past quarter century point up shortcomings in the application equipment, in plant organization, and in attitudes of personnel toward lubrication which should be recognized; corrective action should be taken if these systems are to be the anti-wear devices they potentially are.

There are several ways to make lubrication more effective in the steel industrys' plants. Many of the points discussed are now successfully practiced in some plants; others will be recommendations resulting from observations made during work with lubrication application in many plants. With these considerations in mind, the writer presents the following means of—*Making Lubrication More Effective as a Weapon in Managements' War on Wear.*

I MAKE MANAGEMENT LUBRICATION CONSCIOUS

Top management men whose early experience was concerned with maintenance are usually more cognizant of the importance of lubrication than those whose experience was in production operations. All management, however, can recognize the problem and, as good executives, act on it. Such an attitude is of first importance to the success of any program because their responsibility for production costs dictate the degree that labor and capital will be expended to initiate and carry out any program to improve lubrication practices.

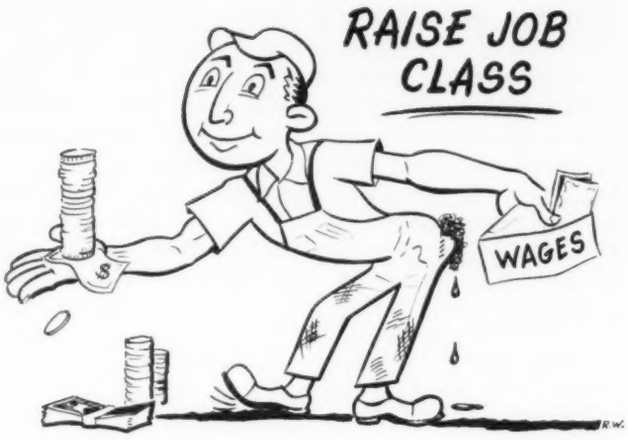
There must be long term goals set by management to effect gradual reduction of R & M costs. Immediate results may not be reflected on cost sheets, but as lubrication application equipment is applied (or existing systems renovated) there will be an eventual improvement in R & M costs. These facts have been proved by experiences in several steel plants.

II SELECT COMPETENT LUBRICATION ENGINEER

The most important component in a successful lubrication program is the man responsible to management for the program. Regardless of his title or his position in the plant organization, he must be a man possessing technical competence and an executive talent; he should have the necessary authority to carry out his responsibilities. The old idea that a good lubrication engineer must be a good salesman should not be true. If there is a sympathetic management, department heads need not make herculean efforts at persuasion in order to stimulate interest in lubrication. The lubrication engineer, or whatever his title may be, should be a staff man with a general concern for all phases of lubrication in plant operations. He should work closely with the plant engineering department in preparing specifications for lubrication equipment that will form part of new plant facilities; he can also have many other duties which will vary from plant to plant. The important thing is this—there should be a specialist in every plant who is mindful of the benefits of good lubrication, is competent, enthusiastic, energetic and never satisfied with the status quo.

III ELEVATE LUBRICATION PERSONNEL

That working with grease and oil should be considered a menial task, rewarded by rates of pay little better than basic, is a reversion to the days of the oil can and grease stick. Capable and conscientious workers cannot be expected to fill these jobs. Capable men, initially assigned to lubrication jobs are promoted to better positions concerned with fixing machinery—machinery possibly broken down through the failure of proper lubrication. The operation and maintenance of grease and oil systems is just as important as the operation and maintenance of any other equipment. Men should be familiar with the mechanical construction of components,



principles of system operation and procedures for repair or replacement of parts. After training, they should be retained on the same job just as long as possible. A rapid turnover of personnel in this function is no more desirable than a rapid turnover of motor inspectors.

IV TRAIN ENGINEERS

Due to the operating principles of various types of lubrication systems, some are more suitable for specific applications than others. Since these systems are expected to be in service for many years under severe operating conditions, their proper selection should be a major interest of engineers. To intelligently analyze and select lubricant application equipment, engineers should thoroughly understand the various principles involved. The training of engineers could be conducted by the plant lubrication engineer, in co-operation with the several suppliers of equipment; as an alternate the steel producer could conduct a program. An illustration of the latter is the United States Steel National Tube Division Mobile Training Clinic. This unit consists of all the components which comprise modern centralized lubricating systems.

The tendency in many instances is for engineers to recopy old specifications which were written many years ago; little thought is given to the possibility that change in equipment design may be indicated. A better understanding on the part of engineers regarding the importance of proper application equipment should stop such practices in future economical plant operations.

V CONDUCT LUBRICATION PROGRAMS

In the realm of safety, continuing campaigns to make men work carefully have resulted in safety records being made—records which were undreamed of a few years ago. Such programs to condition and direct the minds of workers have been proved to be effective; safety is now everybody's business.

The field of lubrication, which is as important to the financial stability of a company as is safety, can be made "everybody's business." If a worker can be made aware of broken lubricant lines, hot bearings, squeaking machinery or contamination of grease and will report this condition to his supervisor (just as he would an unsafe practice), then a great forward step toward successful lubrication practices will have been made. It's all a matter of making the workers aware of the existence of hazards to continued production, etc.

There is an element of personal interest in safety, however, which is lacking in such a campaign as suggested here. As a substitute, an appeal may be made to the employees' pride in his department, the "esprit de corps" of the armed forces. The most effective impetus to such a program could be provided by an extension of a management incentive pay plan. Such an incentive pay would reward workers for their alertness in recognizing and reporting poor practices which would adversely affect production costs upon which their incentive pay could be based. It is realized that such a reward sharing proposal is radical in concept and in variance with existing management-labor relationships, but it would tend to create a personal interest in the welfare of, and a loyalty to the employer. Both these interests have been lessened since the advent of big unionism; they need to be reemphasized.

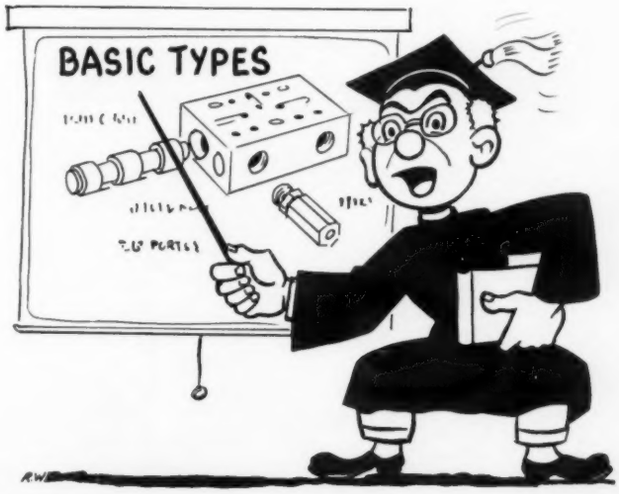
VI EMPHASIZE APPLICATION TECHNIQUES

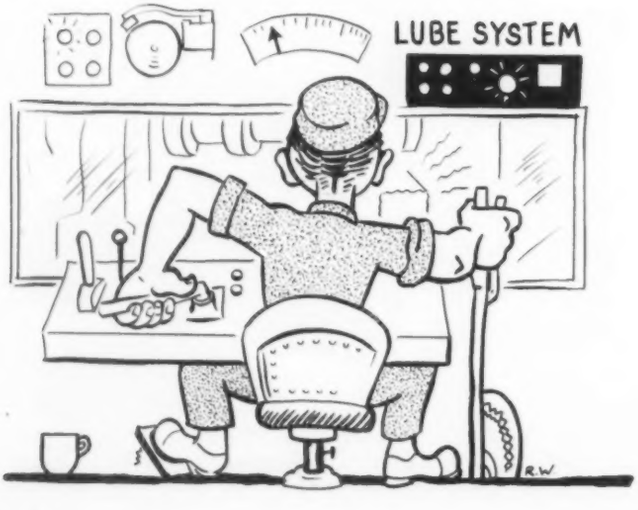
It has been estimated that for every dollar spent for lubricants, four is spent in applying them. The most expensive way to apply lubricants is with a hand grease gun or oil can; the most efficient way is with centralized systems. The area for cost reduction, therefore appears to be in the application of lubricants rather than in the selection of lubricants. Efforts by the lubrication engineer or supervisor toward saving a few cents per pound or gallon in the cost of lubricants does not yield nearly the return that his efforts would realize if directed toward making application techniques throughout his company more efficient. Many times a less expensive lubricant, or even less lubricant, can be used if systems are used to apply them.

Lubrication engineers and lubricant producers have done a noteworthy job in recent years: by continuing efforts to reduce multiplicity of lubricant types used in plant operations; by developing better lubricants for special conditions; etc. It is not the intention to minimize the results of these efforts made in the past and those to come in the future, for they should certainly be continued, but rechanneling some efforts toward application techniques is suggested.

VII REDIRECT THINKING

Another holdover from ancient days is the idea that lubrication systems are a "luxury" item. Recently, a





responsible engineer cut the entire appropriation for lubrication from a budget because the project appropriation was overrun. The same company had just completed a finding which showed that a pilot installation, completely automatic lubricating systems which served all bearings in one of its plants, had resulted in economies which returned the investment in a very short time. But lubrication systems continue to be considered expensive if they cost a few dollars more than a grease gun and fittings. These systems consist of equipment and materials (mostly steel) which must be made on machinery operated by people being paid real wages. Certainly they cost money—but there is a handsome return for their expenditure.

A good rule of thumb to use in estimating the cost of lubricant application equipment is this: the total cost of lubricant application equipment will normally be less than 1 per cent of the total cost of the equipment to which it is applied. Considering the value received over the years the systems will be in service, this is a small price to pay.

VIII DETERMINE TYPE SYSTEM

Previously it has been said that lubrication systems are desirable and effect economies, but it is not enough at this advanced state of technology to let it go at that. In just what degree do they effect economies? Does one type of a system give better results than another? It will be difficult to establish such facts due to the many variables and conditions that affect the problem, but given enough data and using modern methods of statistical analysis some answers will be forthcoming. At least some thought must be given to such questions.

In some plants, a lubrication system installed many years ago effected such an improvement in costs that the same type of systems have been standardized upon, no others having been tried for many years. An old adage says that "a new broom sweeps clean." Perhaps any system would have achieved similar results especially in a situation where any improvement would have been hailed as a great advancement in efficiency. It can be established that one grade of steel gives better results than others, even though any steel is better than wood once was; so it is with lubrication systems. It is now a matter of degree—which type is better, and why?

IX ASSIGN RESPONSIBILITY

When a hydraulic system breaks down, operating personnel ring for the millwrights or pipefitters and the situation is taken in hand. When a motor drive fails, the motor inspector is immediately on the job—with adequate spares at his disposal.

In contrast, when a lubrication line is broken (or valves or pumps become inoperative), it is the rare case when operators are aware of it; the rarer case is when the operator takes measures to have something done about it. There is really no valid reason why this should be the case. It is a matter of education. The fact that the breakdown of a lubricating system has no *immediate effect* on production should not be the reason for complete disregard of them by operators. Such breakdowns will

have some effect, at some time, on production. Many systems installed over the past years, and still being installed today, are of such design that it is difficult for anyone to really determine whether they are operating properly or not. Before the operation of lubricating systems can be made an operating responsibility, they must let the fact of operation or nonoperation be known simply and quickly, as is done in hydraulic and electrical systems. When this is done, mill operators can perform a function as an army truck driver performs before he rolls his vehicle—he checks his lubricant level and pressure gage.

X OPERATE A 100 PER CENT SYSTEM

One of the surprising paradoxes in many steel plants is that of all the equipment and machinery which is purchased and used in the plant, only lubrication systems are not expected to perform at peak capacity. Systems are put into operation and, as the years go by, they become more and more inoperative. Maintenance and repair is delayed and postponed from weekend to weekend. Hand gun fittings are inserted in bearing lines as expedients; finally, there only remains a hodge-podge of piping and valves cluttering up the machinery.

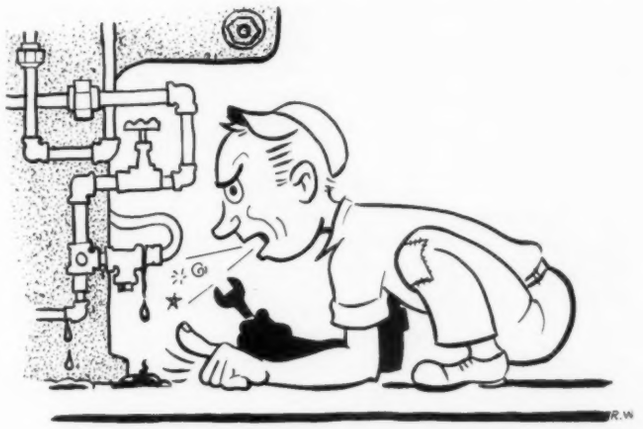
Some types of lubrication equipment can be neglected easier than others. We feel that generally, sequence type systems demand continuing maintenance, whereas the header types can be more easily neglected without anyone knowing about it. Regardless of the type of systems used, they should be expected to operate at 100 per cent capacity. Steps should be taken to see that they do.

It may not be too soon to suggest the use of an outside contract for regular inspection of these systems, assuring a 100 per cent performance. Lubrication systems should, and must, operate at full capacity to be the potent weapons they can be in the war on wear.

XI AUTOMATE LUBRICATION SYSTEMS

As machinery becomes more complex and automatic, there is more need for automatic lubrication devices. Installing manual lubricant pumps to serve systems on modern machinery shows a lack of forethought in design. Manual pumps require manual operation and manual filling of pump reservoirs; both functions are subject to human failure. The drudgery of filling pump reservoirs leads to neglect in filling them. Bearing failures with manual systems can usually be attributed to failure to refill reservoirs and failure to manually operate the pumps; in such cases, the reservoirs may hurriedly be filled to throw bearing failure investigators "off the scent."

Recently, a steel producing company installed grease lubricating systems in a large modern sintering plant. The systems consisted of a large number of manual pumps serving valve systems scattered about an immense area on various levels and subjected to very dirty, dusty conditions. Such an installation is almost incapable of providing the type of lubrication required for modern sintering plants due to the immense job in: first, finding the pumps; second, filling them; third, operating them; and fourth, checking the systems—all these functions require men . . . men for which the maintenance department has few funds to pay.



Manual systems were an improvement over the hand gun and fittings, but they are now being supplanted with automatic or semi-automatic systems wherever possible. Overhead cranes, especially those with a high service demand, should not be equipped with manually operated pumps. Either mechanically driven pumps, electric pumps or feeder systems served by external lubricant supply reels, are much more desirable in modern plants.

Installations such as coal cleaning plants, sintering plants and cement plants are well served by semi-automatic systems employing a single pressurized grease line from centrally located air powered grease pumps. Hoses are "plugged" into this pressurized line and bearings lubricated in the manner that a service station lubricates automobile bearings. At points where many hard to reach bearings are located, a central system can be installed. This system is served from the pressurized line by simply turning a manual valve. In this way no manual pumps are required.

XII MONITOR LUBRICATION SYSTEMS

If lubrication systems are worth installing at all, it is worth knowing that they are operating properly. It would be an ideal situation in a plant if every automatic system had a recorder to monitor it.

In all types of systems the fact of complete main line stoppage of lubricant flow can be recorded. In addition, the sequence type system will indicate on the recorder the stoppage of flow to any individual bearing line (not broken lead lines). The use of such recording devices provides a continuous record of system operation which can be used as a basis for system checking by operating or maintenance personnel. The records are also useful as an aid in the analysis of bearing failures, should any occur. In addition, signal lights and audio warning devices should be used to warn operators of abnormal operating conditions.

Unless systems are capable of use with such devices it is necessary to provide capable inspectors to physically inspect all the valves at regular intervals. Care must be taken in these type systems that the bearings themselves do not become the indicator of system malfunction.

XIII MODERNIZE PIPING

The majority of bearing failures on equipment served by centralized lubrication systems can be attributed to breakdowns in the lubricant transmission system; such leaks and breaks in bearing lead lines cannot be centrally detected by any system. Therefore, the piping system should be installed with materials which will minimize such breakage.

Generally, standard pipe and tapered pipe fittings are less suitable for use with centralized systems than steel tubing with modern "bite" type or flared type tube fittings. These materials provide a natural resiliency and eliminate many sources of leaks, which are brought about by vibration of the machinery. Where vibration is excessive, the use of high pressure hydraulic hose with high pressure fittings is recommended for bearing lead lines. Such a practice is especially desirable on systems installed on overhead cranes, mills, manipulators, etc. Nylon tubing can be used on lighter machinery where it serves as both rigid and flexible lines. Stainless steel tubing should be used as transmission lines on systems serving blast furnace tops and coke plant machinery. Lines running underneath and across mill tables, where water is used as a coolant, should be stainless steel tubing.

As in the case of the systems themselves, little thought is given to the piping system specifications—except to repeat those written years ago. What has been said about lubrication piping systems applies in varying degree to hydraulic systems, where losses of hydraulic oils assume huge proportions on the cost sheet.

XIV INSTALL SYSTEMS

A considerable reduction in R & M costs could be realized if modern systems of lubricant application were installed on old facilities. Not only would such action affect operating economies, but by so doing the life of the facilities may be prolonged many years. The age of a facility should not be the sole criterion determining whether or not lubricant application equipment is installed. The criterion should be the unit cost of maintenance and repair to keep the facility operating. If R & M costs are high due to frequent repairs and replacement of bearings and bearing housings, then a grease lubrication system is desirable. The fact that such installations affect economies has been borne out in many plants. However, there is the feeling in many plants that money spent on any auxiliary equipment for these mills is wasted because facilities will be replaced some day. Many times "some day" has a habit of running into five years or even a decade; in the meantime, high maintenance costs are sustained.

It is advisable to maintain records of bearing life, repair manhours, etc., in a particular facility so that actual savings can be calculated after lubrication systems have been installed. Such records of savings would lead to justification for expenditure for the systems and would serve as a basis for estimating similar savings on other machinery.

SUMMARY

Many of the suggestions made in the foregoing steps which may be taken to make lubrication more effective are difficult or impractical to achieve under present conditions. It is felt that if they were to be put into practice they would have a real effect on the rising maintenance costs in the steel industry.

The suggestions are made with present machine design practice in mind. Research into lubricants and bearing materials may affect the future use of lubrication systems and relegate them to a position of less importance than under todays conditions. The facilities in present use, however, will be in production for many years to come; so until they are completely replaced, the problem of wear will be an ever present one. Lubrication will continue to be the principal means of limiting wear and good lubrication systems—designed, operated and maintained as suggested herein—should continue to be one of the most important concerns to management.

In conclusion, remember wear eats up the profits.

Discussion

PRESENTED BY

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Charles A. Bailey: The steel industry is cognizant of rising repair and maintenance costs and is perceptive of the roll that lubrication played toward reducing these costs; also, of the manner by which improved lubrication technique and organization could further reduce the costs encountered. Through the application of the fourteen insights presented by Mr. Ritter, the further reduction of repair and maintenance costs through more efficient lubrication appears quite feasible.

Being aware of the effectiveness of lubrication in reducing repair and maintenance costs, management in the National Tube Div. of United States Steel Corp. forged ahead to realize the full potential of lubrication. Several methods were employed to disseminate lubrication technology to involved personnel. The first method was the Lubrication Engineers Manual; this semi-formal, loose-leaf manual was divided into three basic sections:

1. Fundamental test procedures (for answering the what, why and how of lubricant tests).
2. Benchmarks or physical constants (for establishing application requirements).
3. Lubrication practice and design (for bridging the gap between petroleum and machine design).

Loose-leaf M. I. Pointers, a second method, involved the informal presentation of skills and knowledge through cartoons . . . an effective medium, as evidenced in Mr. Ritter's presentation. The most recent method incorporated the lubrication clinic of the mobile training unit. Within this unit, formal training programs are conducted to impart the necessary theoretical knowledge and job know-how to all employees responsible for the proper maintenance of a plant's lubricating equipment. Various technical papers before societies such as this were employed to spread lubrication technology; an earlier lubrication program was revised and reinstated. The objective of all these endeavors has been, and continues to be, the reduction of a plant's equipment failures due to improper lubrication through improved maintenance.

Yet, if we are to fully realize the effectiveness of lubrication in the war on wear, a necessary weapon must be supplied. Lubrication, as a technology, is in need of a comprehensive text. Although many worthwhile books and papers dealing with lubrication technology have been published, none have been all inclusive; each has been a specialist's treatment of a particular phase of lubrication. No one book contains sufficient theoretical and practical information about fundamentals, lubricants, devices and methods of application to satisfy the engineer, the designer or the machinist . . . not to mention the forgotten novice and student of lubrication. Still, there are latent volumes of lubrication technology in the realms of supplier research and consumer experience; this information must be transmitted to an academic level for use throughout industry, as well as in universities. The transmission of lubrication technology will require a broad-scope-training program based upon organized information; by this manner, the technology of lubrication will be extensive. When this is accomplished, lubrication will become a more effective weapon in the war on wear to reduce repair and maintenance costs.

V. H. Lindberg: The suggested modes of attack to reduce costs are definitely practical and are necessary tools to be used by modern maintenance and operating personnel responsible for good effective equipment utilization. The increase in labor and equipment cost replacements makes it mandatory to move in the direction indicated.

The last twenty years has seen a considerable increase in ingot tonnage and many steel plants have been caught with insufficient primary and secondary rolling mill capacity during peak periods, and as a result these specific bottlenecks created serious customer relations and plant operating problems. To get out of such bottlenecks many rolling mill operators were forced to roll twenty out of a possible twenty-one turn operation each week to stay ahead of ingot production.

This type of operating plan can be utilized during a limited period of time but eventually serious breakdowns result creating more severe losses in tonnage. The only approach to this problem is through an attack on mill delays that occur on operating turns. Maintenance usually plays the largest part in this attack and for this reason all pieces of mill equipment must be carefully analyzed and preventive measures taken to reduce these delays. Lubrication can and does play an important part in this attack.

The installation of automatic lubrication systems has paid off in many corporation plant units and we are at present continuing this same method of approach in other units of the structural rolling division at South Works.

The present lubrication program involves two basic problems:

1. The rehabilitation and the improving of old automatic systems and the installation of more modern types throughout rolling mill areas on equipment built and installed during the early 1900's.

2. The installation of new and improved lubricating systems on equipment in conjunction with the new structural rolling and finishing facilities now being installed at South Works.

This program demands extensive training of supervision and personnel. It also requires changes in thinking in the utilization of equipment, and last but not least, a control of expenditures based on a dollar return factor.

There is a long way to go but so far the program has started to pay off in reduced delays on rolling mill units, and this lubrication program will be expedited much in the same manner as suggested in the paper.

S. C. Read: The steel industry appreciates the assistance received and the progressive attitude of suppliers toward improvements.

Mr. Ritter's paper is a stimulant to advance lubrication procedures. Probably all who are responsible for the operation or maintenance of mill equipment have spots where lubrication efficiency can be improved . . . and good lubricating systems are available. Some may have a personal preference as to the type and design, but these views may be attributed to individual experience. The design for specific jobs is of value, but from mill experience, the method of operating the system and the maintenance care it receives are factors that also contribute to satisfactory lubrication. Good lubrication systems have been observed that fail to function properly due to neglect of proper maintenance. So, we support the point that the lubrication system should receive attention by skilled mill operators and that the designers and manufacturers should continue to develop and improve this equipment.

M. E. Olson: The author has presented a very clear picture of what a good lubrication organization can do to reduce maintenance costs and also how to accomplish an effective organization. The fact that lubrication has been generally left to lower echelons is not a new lament. Actually it has been a source of much discussion but very little action has been taken to raise job classifications of lubrication men to insure competent men on this job. It would be interesting to hear how this problem was solved by others.

A lubrication school was started at out plant several years ago. All maintenance men were exposed to different types of lubrication equipment and how they functioned, as well as a simplified lecture on various types of greases. This instruction was a definite help in obtaining better lubrication. Due to the large turnover in lubrication men, it is important to repeat these instructions periodically.

It would be of interest to know if anyone has developed a program for incentive rewards in connection with alertness and reporting upon lubrication and, if so, how successful such a program would be in getting better lubrication.

Lee O. Witzenburg: The author has written what everyone should know for himself as being self evident "common sense"; —but it is surprising how many need often to be reminded of the importance of, and the money saving to be realized with good lubrication, planned lubrication practices and the best in lubrication devices.

When the basic principle of a service product, such as a lubrication system, is good and has been proved by the years, it does not necessarily make sense to try something new. Many times the new product is merely a revision of a design that was found lacking and, although perhaps improved, is still not the answer to the lubrication engineer's prayer. Some excellent products do not require a yearly model change to perform their intended function.

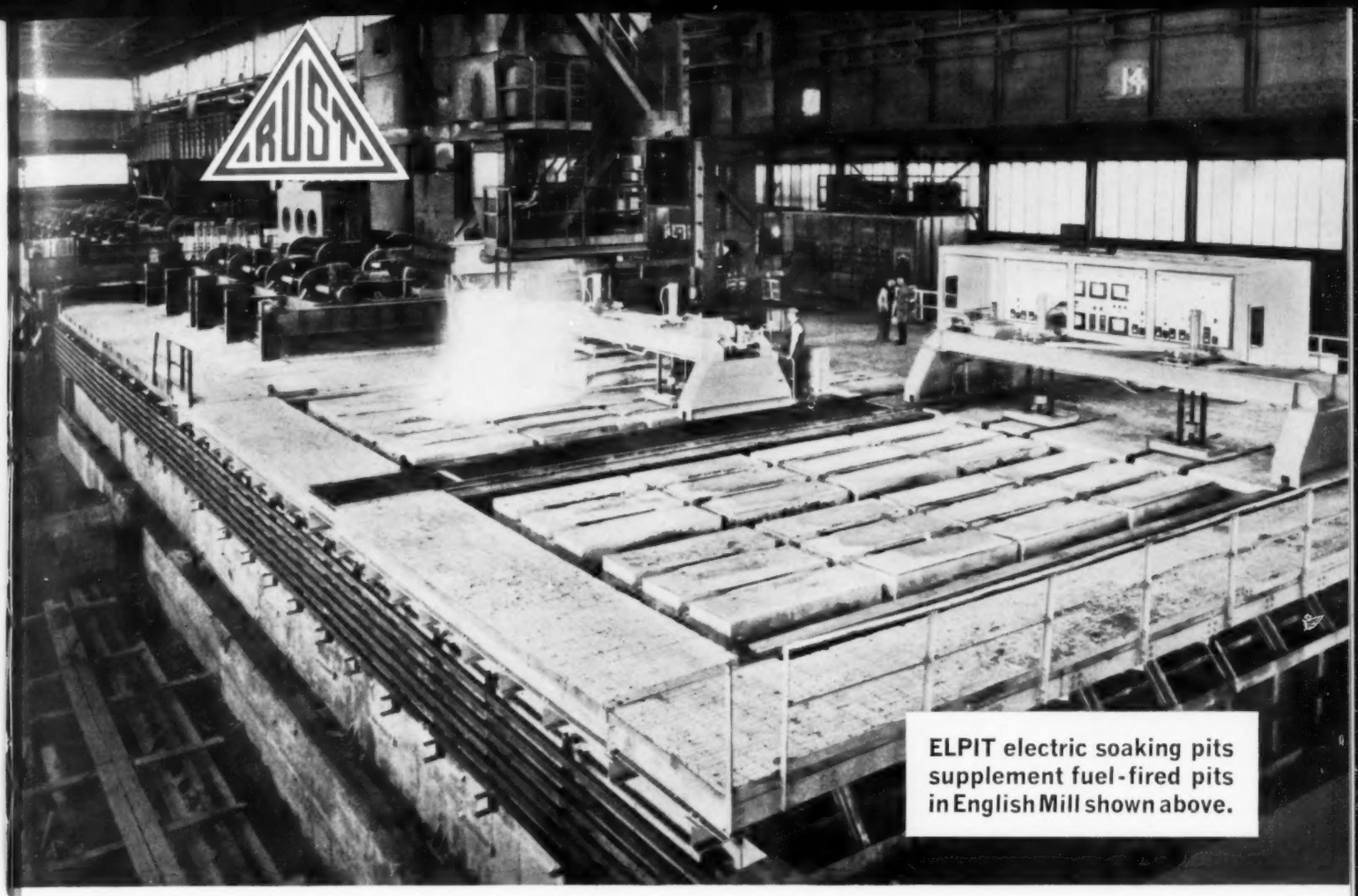
Centralized lubrication systems that require inspection at periodic intervals have many times been proved to have an advantage all their own. Horns, bells, blinkers, recorders and other warning devices can be made a part of any type automatic system and, within limits, are an aid but none of them can detect, as the author points out, broken or leaking lines to bearings. Warning devices tend to lull us into a sense of false security—no warning is given, so we assume that everything is perfect. But even warning devices can fail. And, it is still good practice to periodically make sure that each bearing is being served and its lead line is still there. We have never yet seen a quality piece of machinery whose manufacturer did not recommend periodic inspection as good maintenance practice.

Even with the most modern of today's equipment, automatic centralized systems are not always the wise choice. There is still the matter of economics to consider—why spend extra money if you do not have to? Perhaps the bearings need lubrication only once or twice a month—which certainly does not justify an automatic system.

Mr. Ritter drew attention to a recent installation with a large number of manual systems in a new modern sintering plant. That company's wise and experienced engineers decided that those manual systems were the best choice for the applications on which they were used. That same sintering plant has three very large sintering machines which are the heart of the operation. Those machines are served by three of the largest motor-driven automatic systems ever built. Three other automatic systems serve auxiliary equipment on the main sintering machines. One third of the manual systems are on shuttle cars and swing conveyors —each having its own self-contained system. The balance serve the main junction points of over four miles of conveyors located in five buildings and covering approximately four acres. The manual pumps on these are located at key operational points conveniently accessible for the operators. And, it should be pointed out that the manual systems serve bearings that call for lubrication only once or twice per month. Automatic systems here would have been extremely costly, well nigh impossible to install, and certainly not needed due to the infrequent lubrication cycle. It even costs money to maintain lubrication systems—much more for automatic than for manual. So there is a point at which manual systems still make good sense.

Wayne G. Ritter: We appreciate the spirit with which this "pep talk" has been received by various representatives of the steel industry. The paper was intended to be constructive, even though critical of various existing practices.

To Mr. Witzenburg, who represents a competitive supplier of lubricating equipment, we can only say that just this year his company introduced a "new model" in the form of a sequence type system. Until this time any citing of superiority of the sequence type system in certain respects would not have been fair or ethical since the sequence type system was the exclusive province of one of their major competitors. ▲



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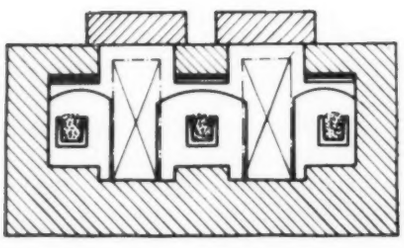

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EP-1

Gas Mixing Stations Can Cut Fuel Costs

by R. E. BLACKWELL, Manager, Steel Industry Sales,
Hagan Chemicals & Controls, Inc., Pittsburgh, Pa.,
and N. P. JACOBY, Vice President, Parr Engineering, Philadelphia, Pa.

THE plant fuel engineer, bent on thrifty utilization of so-called "waste" or by-product fuels, and faced with an ever-changing situation as to their availability, can never relax his search for new methods or for new ways of applying old methods.

Improved blast furnace techniques are reducing coke rates, cutting blast furnace gas production per ton of iron, lowering Btu content, using more of the gas in the stoves. Less and less of this fuel is available for use elsewhere in the plant. This is but one facet of the constantly changing fuel utilization picture.

In some areas, more natural gas is becoming available on a dump basis. The economics of price and quantity call for another look at ways and means of introducing this fuel into iron and steelmaking processes. The gas mixing station is one of the fuel engineer's most useful weapons in the battle with fuel costs.

MIXING STATIONS—THEIR PURPOSE

Gas mixing stations in steel plants may be designed to perform any one or more of several functions:

1. To stabilize pressure in a plant gas system, as for instance at the far end of an inadequately-sized distribution line.
2. To make up for steady deficiencies in the supply of plant gas. This might occur in a plant where the coke oven capacity is greatly outbalanced by the normal demand for coke oven gas.
3. To supply intermittent peak demands which go beyond the normal gas generating capacity of the plant.
4. To produce a gas of certain flame or combustion characteristics different from the available gases. A good example of this is the mixing of a low Btu gas for use in soaking pits to improve the gas circulation, and hence the temperature distribution, in the pit. Or the use of inert hydrogen-nitrogen mixtures in critical metallurgical processes.
5. As a stand-by facility to be relied upon for gas production only in an emergency.
6. To make use of low-priced fuels.

DESIGN CRITERIA

Design of gas mixing stations must take the foregoing into account, together with such factors as the following:

1. Availability and characteristics of the gases constituting the mixture.
2. Range of turndown of flow to be expected during normal operation.
3. Complete safety of operation.
4. Avoidance of excessive demand charges where gases are to be furnished under contract with a public utility.

FIXED ORIFICE VS VARIABLE ORIFICE CONTROL

Control of gas mixing stations is generally accomplished by ratioing together the measured volumes of two or more gases. This can be accomplished, with maximum ratioing accuracy, in limited turndown stations which measure the differentials across fixed orifices. Wider turndown, with some sacrifice of accuracy, can be accomplished by varying the area of an orifice (valve) across which a constant differential is held.

It must be carefully kept in mind that the accuracy of a wide turndown station depends on the ability to match the characteristics of two valves as they are positioned together throughout their range. Metering accuracy of such a station cannot continuously and reliably match the accuracy of a fixed orifice station above 10 per cent, but, when properly calibrated, can do a superior ratioing job below 10 per cent of maximum flow.

Examples of these two approaches are described.

BTU OR SPECIFIC GRAVITY CONTROL

Occasionally, it is suggested that the volume ratio control should receive a trimming action from some final parameter, such as Btu or specific gravity. This is perfectly feasible provided the measurement of Btu or specific gravity is fast and completely reliable. Oftentimes, a record or indication of Btu or specific gravity is provided to give a check on the operation of the station.

PRACTICE AND EXPERIENCE

Our company has furnished gas mixing station control for both wide range and limited turndown stations built for the several purposes already mentioned. Using pneumatic controllers and ring balance flow meters, Hagan can accept the entire control and instrument responsibility. Examples of earlier stations are the ones at Armco (Middletown) and Jones & Laughlin (Pittsburgh), both mentioned in a paper by H. V. Flagg, published in the 1956 Proceedings AISE.

An example of a more recent installation is the one at Alan Wood Steel Co., installed in 1959. This station mixes natural gas and air to supplement the plant coke oven gas supply and to utilize surplus natural gas purchased under a contract which imposes penalties for exceeding hourly demand rates and for exceeding a 24 hr maximum.

The ratio of natural gas and air is such as to produce a mixture having a flow factor or Wobbe index, the same as that of the plant gas. Thus, the mixed gas and the plant gas are used interchangeably and in any proportion by all of the measuring and controlling devices in the plant without disturbing fuel-air ratio settings.

$$\text{Wobbe Index} = \frac{\text{Btu per cu ft}}{\sqrt{\text{specific gravity}}}$$

It will be seen that this index

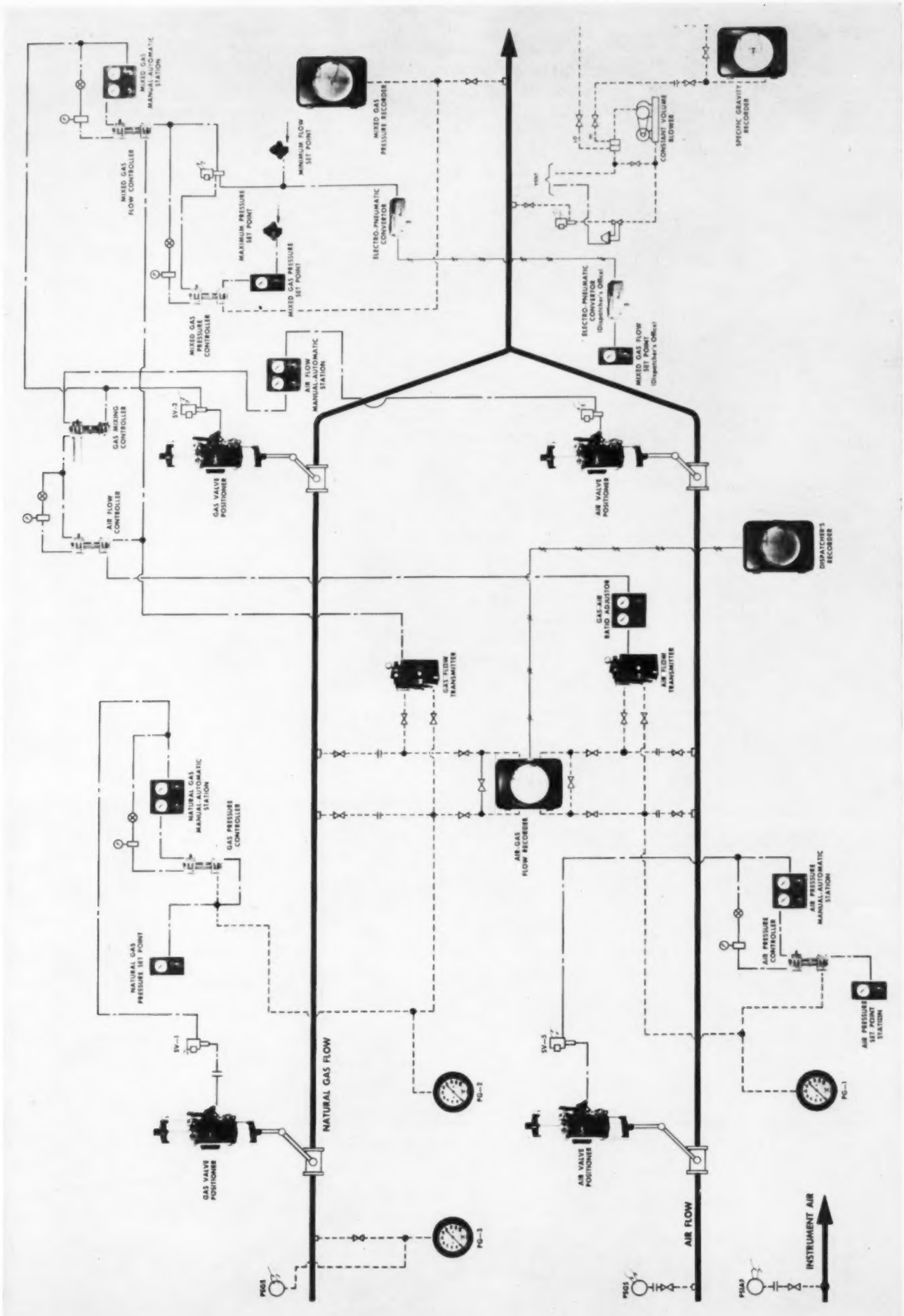


Figure 1 — Schematic shows fuel control system recently installed for Alan Wood Steel Co.

takes into account both the change in Btu value and the effect, on orifice measurement, of the change in gravity.

For instance, if it is desired to mix natural gas (1050 Btu, 0.61 specific gravity) and air to supplement coke oven gas (550 Btu and 0.4 specific gravity).

Let A = the air fraction; let 1-A = the natural gas fraction and equate Wobbe indexes thus:

$$\frac{1050(1\text{-}A)}{\sqrt{0.61\ (1\text{-}A) + A}} = \frac{550}{\sqrt{0.4}}$$

Then A = 0.29 and 1-A = 0.71.

The heating value of the mixture will be 745 Btu, the gravity 0.723, and all orifices in the plant will give the same Btu per hr measurement whether on one gas or the other, or any proportion in between.

DESCRIPTION OF OPERATION

Figure 1 is the schematic for the Alan Wood Steel Co. station. This station may be used to stabilize pressure in the plant system, or it may be put under remote supervision of the gas dispatcher who can adjust a constant flow of mixed gas so as to avoid excess demand charges.

This station was specifically designed for an anticipated turndown of approximately 10 to 1 and, in order to obtain maximum accuracy, the fixed orifice arrangement was selected. It will be noted (noon on July 15 chart) that specific gravity goes a little low when station load falls to zero; otherwise, it is evident that ratios are being held quite closely.

When operating to stabilize plant gas pressure, the mixed gas pressure controller feels plant header pressure and calls for a mixing station output which will hold the header pressure constant. The pressure controller cascades on to the mixed gas flow controller, giving it a variable demand or set point.

When under load dispatcher control, the cascade signal from the pressure controller can be interrupted by remotely energizing SV-3, and the manually-adjusted flow set point signal is substituted for it. This signal is electrically transmitted from the dispatcher's office, and reconverted into a pneumatic signal at the mixing station. The addition of another remotely operated solenoid valve would give the dispatcher a means for adjusting the pressure set point from his office, if desired.

The flow controller moves both the air control valve and the gas control valve simultaneously in parallel.

The air flow controller compares air flow with gas flow, and applies a vernier correction to the air control valve position through the gas mixing controller.

Air pressure and gas pressure are controlled constant ahead of the air and gas control valve.

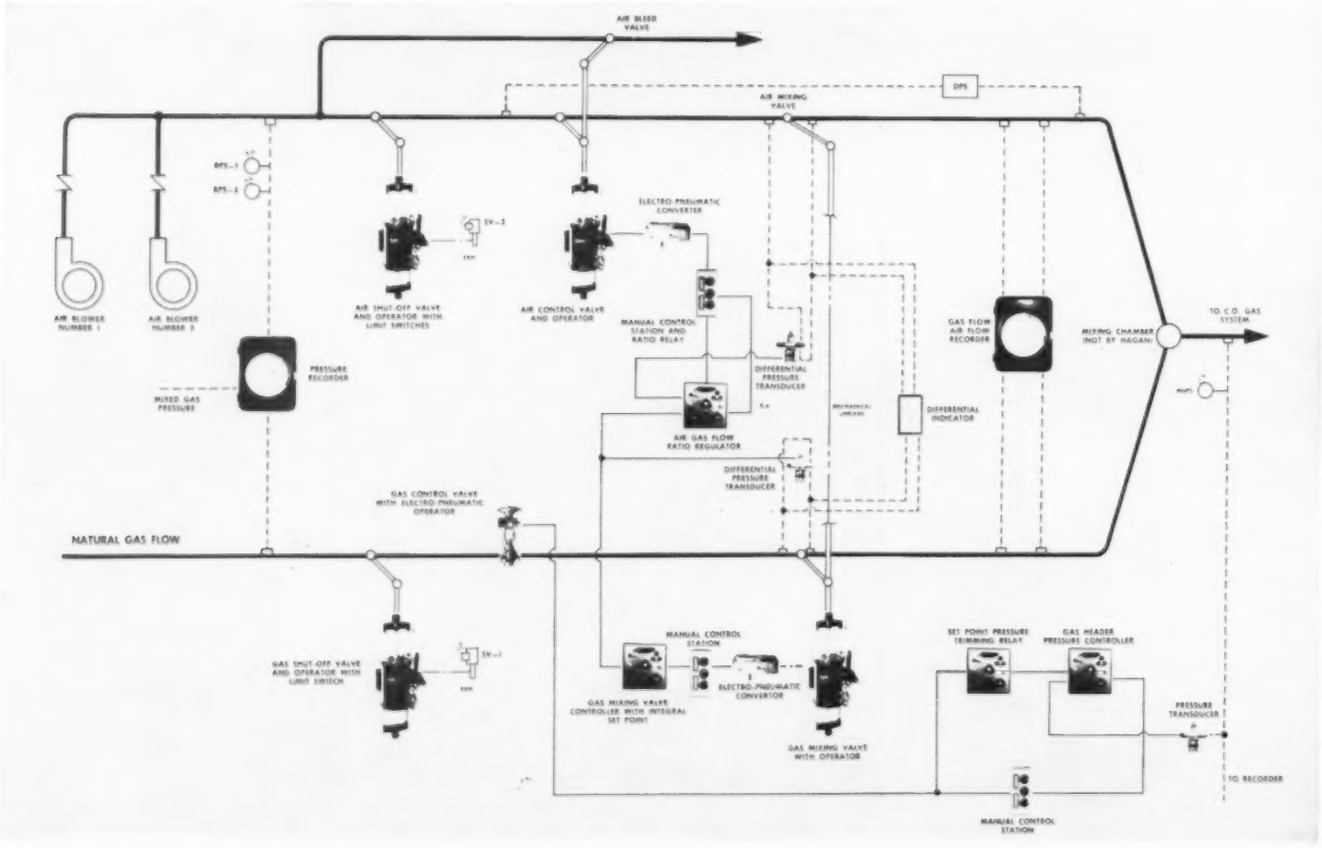
Gas header pressure, air and gas flow, and specific gravity are recorded.

SPECIFIC GRAVITY RECORDER

The development of a specific gravity signal is interesting. A simple constant volume blower circulates a sample of the mixed gas through a fixed orifice. By regulating a constant pressure in this orifice run, and assuming a constant temperature, any variations in the differential across the orifice are a direct measurement of specific gravity changes.

The performance of the ratio control system is portrayed by the specific gravity chart. Here a greatly suppressed meter provides an independent performance record having a readable accuracy and sensitivity of better than 0.01.

Figure 2 — Typical control diagram uses valve as variable orifice.


AIR BLEED VALVE
AIR MIXING VALVE
DPS
AIR BLOWER NUMBER 1
AIR BLOWER NUMBER 2
PRESSURE RECORDER
MIXED GAS PRESSURE
AIR SHUT-OFF VALVE AND OPERATOR WITH LIMIT SWITCHES
AIR CONTROL VALVE AND OPERATOR
ELECTRO-PNEUMATIC CONVERTER
MANUAL CONTROL STATION AND RATIO RELAY
DIFFERENTIAL PRESSURE TRANSDUCER
AIR GAS FLOW RATIO REGULATOR
GAS FLOW AIR FLOW RECORDER
DIFFERENTIAL INDICATOR
MIXING CHAMBER (NOT BY HAGAN)
TO C.O. GAS SYSTEM
GAS CONTROL VALVE WITH ELECTRO-PNEUMATIC OPERATOR
NATURAL GAS FLOW
GAS SHUT-OFF VALVE AND OPERATOR WITH LIMIT SWITCH
MANUAL CONTROL STATION
ELECTRO-PNEUMATIC CONVERTOR
GAS MIXING VALVE CONTROLLER WITH INTEGRAL SET POINT
GAS MIXING VALVE WITH OPERATOR
SET POINT PRESSURE TRIMMING RELAY
GAS HEADER PRESSURE CONTROLLER
PRESSURE TRANSDUCER
TO RECORDER
MANUAL CONTROL STATION

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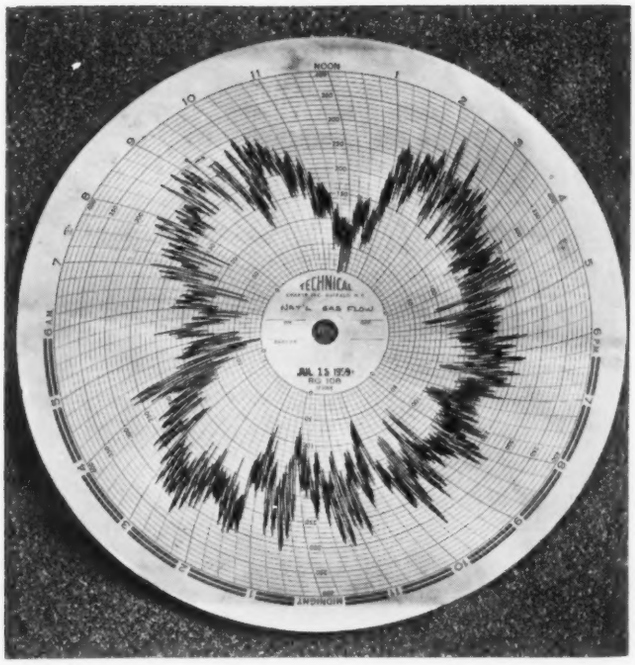


Figure 3 — The nature of the load on the station when operating to stabilize gas pressure is indicated by the rapid fluctuations in recorded flow. The chart shows both natural gas and air flow.

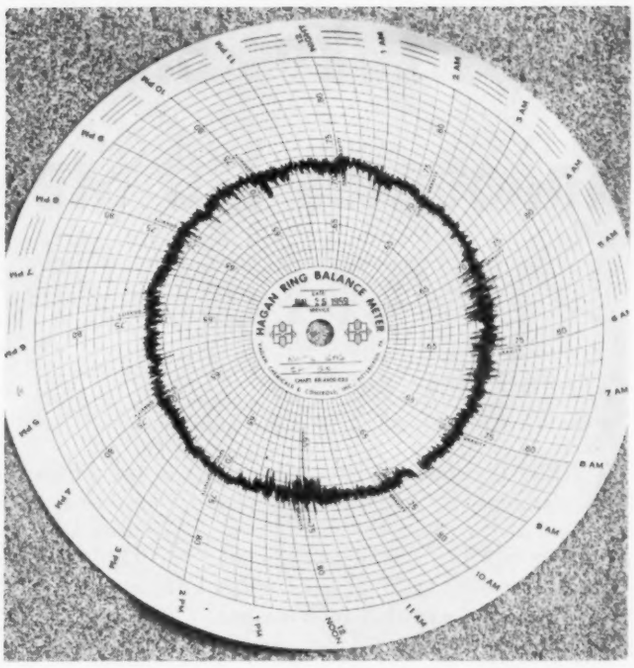


Figure 4 — Comparison of this specific gravity record with the gas and air flow record of the same date (Figure 3) shows that the gas/air ratio is being held satisfactorily through severe station load fluctuations.

COMPUTER CONTROL

Considerable thought has been given to complete automation of the gas mixing station so as to relieve the dispatcher of decisions relative to adjusting flow rates to avoid excess demand charges. It is recognized that automation of any plant process must take into consideration the many facets characteristic of the particular process, and a system designed to best meet the conditions encountered. With this in mind, any one or a combination of the following could readily provide continuous and accurate information available to the fuel dispatcher.

1. Continuously display to the dispatcher the following information:
   a. Remaining hours in 24-hr day.
   b. Gas remaining in 24-hr allowance.

From these two factors, the dispatcher can recompute hourly the flow rate which will use up the gas remaining without exceeding the 24-hr allowance before the end of the day.

2. Continuously compute for the dispatcher the quotient:

$$\frac{\text{Gas remaining}}{\text{Hours remaining}} = \text{allowable flow rate}$$

From this computation, the dispatcher can readjust the flow set point at suitable intervals.

3. Continuously provide a computed set point signal which will automatically readjust the station flow so as to use up, but not exceed, the 24-hr allowance.

4. Many times mill operations require that peak demands be met before a 24-hr period is complete, resulting in reduced or little gas requirements afterward. In such cases, a continuous display of permissible hours of gas usage at the current demand rate will permit the dispatcher to match station gas availability with predicted mill schedules. This would be supplied by continuously computing the quotient:

$$\frac{\text{Total cu ft gas allowable in 24 hr}}{\text{Current rate cu ft per hr}} = \text{Remaining hours gas available at rate of usage}$$

Step (1-b) is presently installed and consists of an integrator impulse generator which gives a pulse for every 1000 scf. These pulses are counted on a Veeder-Root counter, which can be set to alarm after any predetermined number of pulses, and which is automatically reset to zero after 24 hr.

SAFETY INTERLOCK SYSTEM

In general, electrical interlocks must be provided to assure safe start-up and operation of the station. These should provide suitable alarm signals and shutdown of the station on loss of either or both gases, or failure of instrument air, or electrical failure of the air compressors. Interlocks should also command the start-up under a safe sequence.

VARIABLE ORIFICE CONTROL

Figure 2 illustrates a typical control diagram, employing characterized control valves as variable orifices. Here, the prime consideration is close control of ratio all of the way down to shutoff.

The two valves are mechanically linked together and positioned from a common valve positioner.

The station operates to maintain pressure in the plant gas header by admitting a mixture of natural gas and air when required.

Gas is admitted ahead of the gas mixing valve by the gas control valve, in response to the gas header pressure controller.

The gas mixing valve controller acts to hold a constant differential across the gas mixing valve. As the latter changes position, the position of the air mixing valve is also changed by a corresponding amount.

The air gas flow ratio regulator acts to hold the differential across the air mixing valve in some preset ratio to the differential across the gas mixing valve. ▲

Great Lakes Steel Corp. Announces L-D Steelmaking Plant

A NEW two-furnace basic oxygen steelmaking shop will be constructed at the plant of Great Lakes Steel Corp., Detroit subsidiary of National Steel Corp. This installation will be an addition to National Steel's current $300,000,000 expansion program. It will further augment the program's major purposes which are to affect cost reductions throughout National Steel operations; to raise control of quality to new and uniform high levels, and to develop an even greater elasticity of product specifications in respect to quantity and quality which will enable the company to make an important forward step in service to customer.

The oxygen furnace shop will be housed in a 280- by 700-ft building. Principal facilities will consist of the two furnaces, each of which will have a capacity of 250 tons per heat and will be the largest ever built. The shop will be equipped with numerous auxiliary facilities including electrostatic precipitators which will remove solids from the gases generated in the steelmaking process.

Site preparation will begin following the letting of contracts in the near future and it is anticipated that the shop will be pouring steel within 18 months after the start of construction.

The estimated annual capacity of the oxygen furnaces is 2,000,000 ingot tons. There will be a partial replacement of existing open hearth capacity but the over-all effect of the new shop will be to increase the total active steelmaking capacity of Great Lakes Steel Corp. to 4,200,000 tons per year. All present open hearth facilities will be retained and any inactive furnaces will be maintained for operation in periods of peak demand for steel.

National Steel's $300,000,000 program of expansion and improvement has been in progress since early 1959 at three major plant locations.

The total program includes the construction of the entirely new finishing plant of Midwest Steel Corp. in the Chicago area; the installation of an 80-in. hot strip mill at Great Lakes Steel, and extensive additions and improvements to facilities for the production of tinplate and cold rolled sheets at the Weirton Steel division.

The Midwest plant will be devoted to the production of tinplate, continuous galvanized steel, and hot and cold rolled sheets and strip from hot rolled coils to be supplied by Great Lakes Steel. The plant is expected to be in full production in mid-1961.

Now under construction at Great Lakes Steel is an 80-in. hot strip mill. This facility will be the fastest and most powerful hot strip mill ever built. It is the first to have an electronic computer included in its original design; its capacity will be 3,600,000 tons per year, and it will roll slabs and produce coils more than twice as large as the average on existing mills of this type. Initial operation of the 80-in. mill is scheduled for the second quarter of 1961.

With the new facilities, Great Lakes Steel will be able to supply the initial requirements of Midwest Steel and also meet peak demands of its principal customer, the automotive industry, with steel of the highest quality yet produced. He pointed out that a highly important result of the program will be to level the peaks and valleys of production that result from the fluctuating nature of the Detroit steel market.

The adoption of the basic oxygen steelmaking process has been accelerating in the steel industry because it affords speed of production, greater economy and a high quality product. The furnace is a bottle-shaped vessel constructed with a shell of heavy steel plates lined with refractory brick. The furnaces at Great Lakes Steel will be about 29 ft high and also 29 ft in maximum diameter. The refractory linings will be more than three feet thick at their widest point. ▲

Air Compressor At New Gas Mixing Station Will Be Driven By Natural Gas Pressure

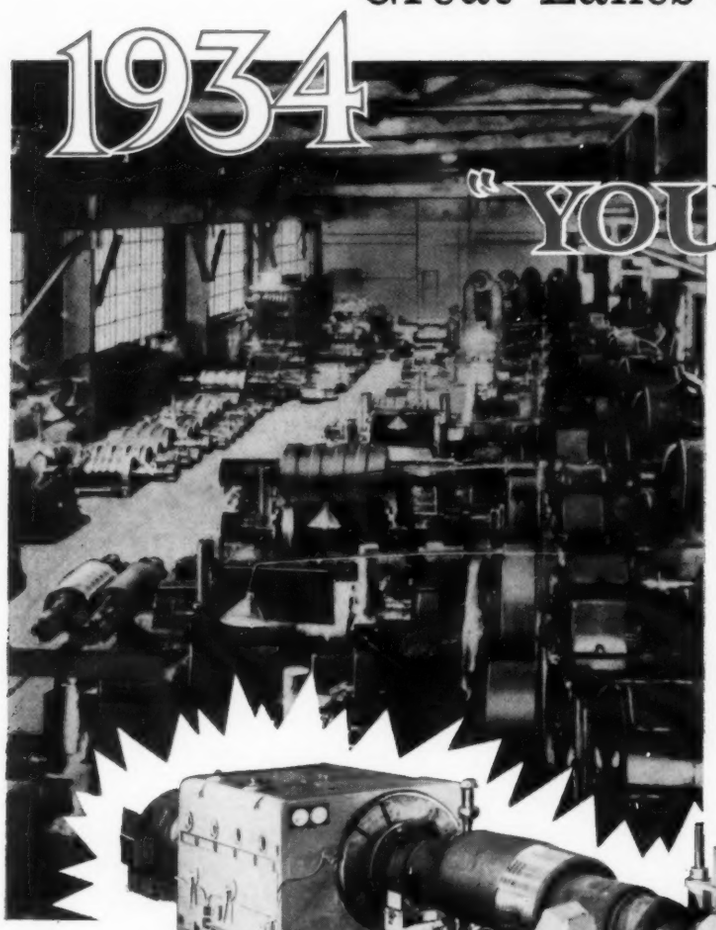
NATURAL gas pressure will be used to drive air compressors for the new gas mixing station at Republic Steel Corp., Warren, Ohio.

An all-hydraulic control system by GPE Controls, Inc. will control gas flow and pressure to a gas expander used to drive an air compressor coupled to the expander shaft. Pressure, flow and proportioning control is accomplished without the use of electrical accessories as all interlocks are hydraulic.

The station is expected to supply mixed gas of accurately controlled heating value over the turn-down range of 30 to 1 or more.

This gas-driven system will derive the maximum amount of power from the high pressure gas supply by utilizing the pressure drop through the expander to boost the air from atmospheric condition to the mixing pressure.

Great Lakes Steel Corporation...



a 26-year user of "YOUNGSTOWN" *Heavy Duty* ROLL LATHES

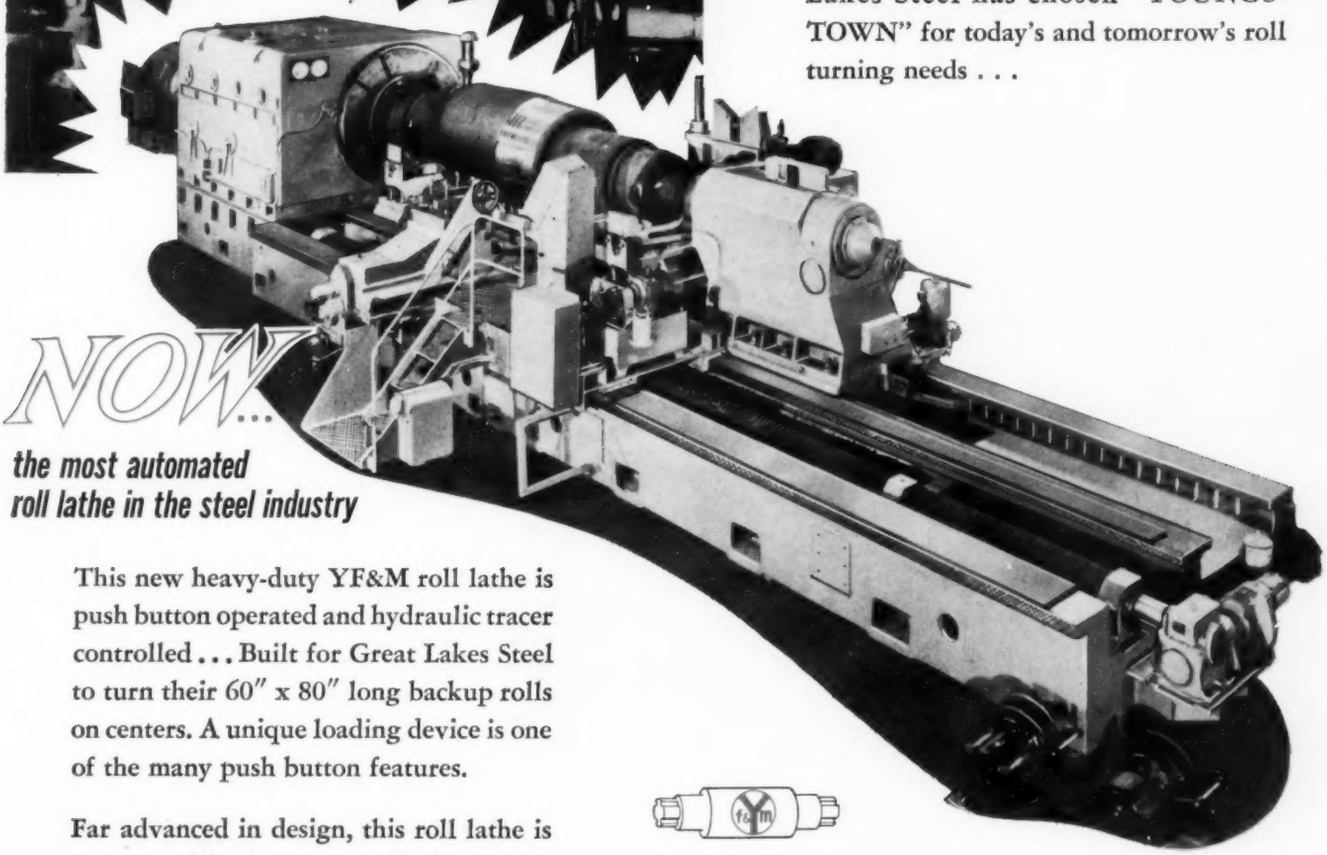
In 1934, when Great Lakes Steel Corporation first purchased roll lathes for turning merchant mill rolls, The Youngstown Foundry & Machine Company was selected to build these lathes (pictured at left) . . . They are still operating. Now, with the advent of the new high-speed computer-controlled hot strip mill, Great Lakes Steel has chosen "YOUNGSTOWN" for today's and tomorrow's roll turning needs . . .

NOW...

the most automated roll lathe in the steel industry

This new heavy-duty YF&M roll lathe is push button operated and hydraulic tracer controlled . . . Built for Great Lakes Steel to turn their 60″ x 80″ long backup rolls on centers. A unique loading device is one of the many push button features.

Far advanced in design, this roll lathe is engineered for future numerical tape control. Write for complete information.



This lathe is capable of turning rolls 70½″ diameter and 24′ long, with a maximum weight of 140 tons on centers at speeds of 1.3 to 228 RPM.

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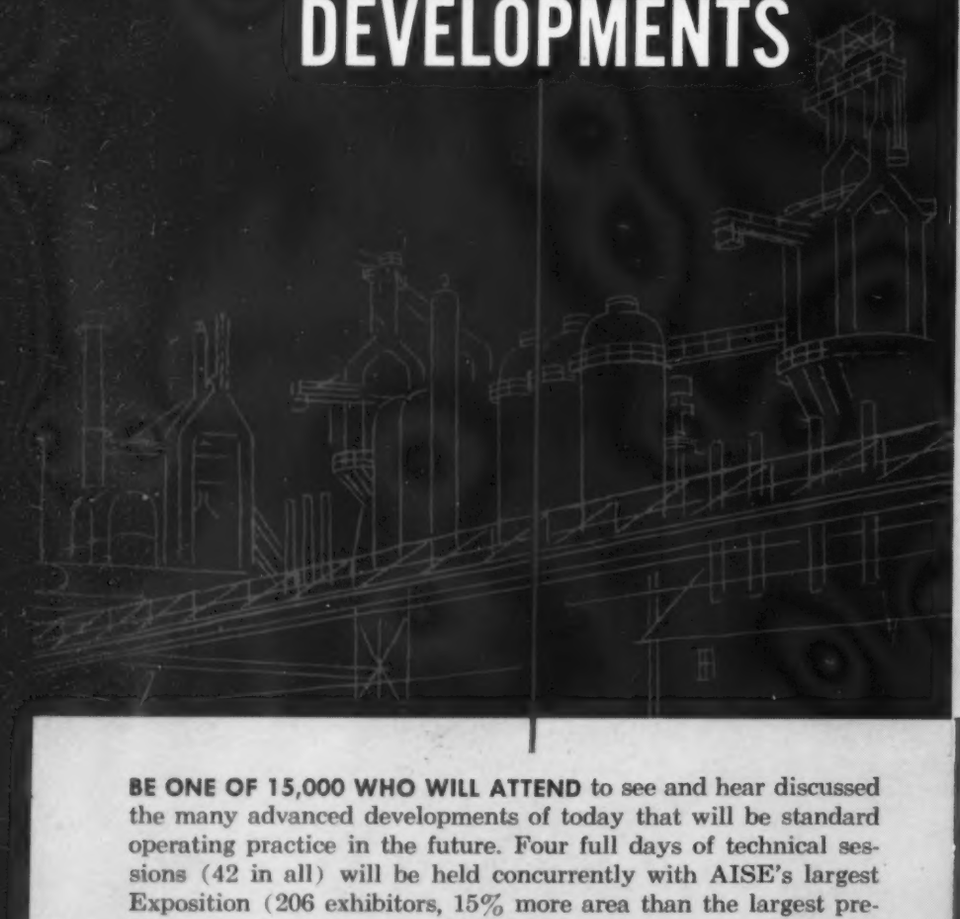

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SEPTEMBER 27-28-29-30, 1960 • CLEVELAND PUBLIC AUDITORIUM

Granite City Steel Adds To Expansion Program

THE board of directors of the Granite City Steel Co. on Aug. 10 approved the construction of a battery of 61 coke ovens and a high-speed continuous annealing line to process light gage steel for tinplate—adding those projects to the company's current expansion program.

Construction underway and previously scheduled will increase Granite City Steel's annual open hearth capacity from the present 1,440,000 tons to 1,740,000 tons by 1962. Additions to rolling and finishing departments will enable the company to increase production of cold rolled products including galvanized and tinplate.

Granite City Steel, largest steel producer in metropolitan St. Louis, supplies manufacturers in the Midwest and Southwest.

The directors also approved an arrangement for a $30,000,000, two-year, revolving credit with seven banks, convertible at the company's option to a four-year term loan. This new loan arrangement became necessary with the enlargement of Granite City Steel's expansion program, and it replaces a $17,000,000 bank credit arranged a year ago but never used.

The 61 Koppers-Becker low-differential, cross flow, gas gun type, combination by-product coke ovens will be constructed for Granite City Steel by the Koppers Co., Inc., of Pittsburgh. Completion is scheduled for September 1, 1961. Each oven will take 17.2 net tons of coal per charge. The battery will carbonize about 1525 tons of coal per day and produce about 1000 tons of coke—adding about 80 per cent to Granite City Steel's present coking capacity in two batteries of ovens, and making the company self-sufficient in coke production.

Granite City Steel will also alter and add to its by-product and benzol plants and will expand its quenching station and coke wharf.

The coke oven battery is needed to support the company's expanded blast furnace plant, which will be able to produce about 1,134,000 tons of pig iron a year after a blast furnace with a 28-ft hearth diameter and a daily capacity of 1800 tons of pig iron is blown in next October. This furnace, one of two, will have double the capacity of an old furnace it replaces.

The 42-in. continuous annealing line will operate at speeds up to 1200 fpm. Machinery for the 375-ft long line will be supplied by the Wean Engineering Co., Inc., of Warren, Ohio. The tower-type Drever furnace in the line, surrounded by structural steel operating platforms, will be 73 ft high, and divided into four sections, with their effective length increased by threading the steel back and forth around rolls at the top and bottom of the heating and cooling towers.

The moving strip of tinplate steel will be radiation-heated to 1350F, in 18 sec in a natural-gas-fired heating zone, soaked at the same temperature for 24 sec in an electrically-heated holding zone, radiation-cooled to 900 F, in 18 sec, in a slow-cooling zone, and finally cooled to 150 F in 36 sec in the fast-cooling zone by blowing the protective gas atmosphere against the strip. The atmosphere in the heating and cooling towers will consist of 95 per cent nitrogen and 5 per cent hydrogen. The 105 recuperative-type burners in the furnace will have a total maximum gross input rating of 21,000,000 Btu per hr.

Scheduled for completion in January, 1962, the annealing line will have a capacity of about 20,000 tons a month. The closely-controlled heating conditions in the continuous annealing process minimize variations in hardness and produce a more uniform fine grain structure for tinplate steel than the older batch or coil annealing process.

This will be the third major new unit that is included in the current expansion. The company increased its tinplating capacity 1½ times last spring with a second electrolytic tinplate line. The Waterbury Farrel Foundry and Machine Co., a division of Textron, Inc., is now building the most powerful sendzimir cold strip mill thus far designed for Granite City Steel. This nonreversing, 6400-hp unit will finish the cold reduction of the light tinplate gages at speeds up to 3500 fpm. The company's four-stand cold strip mill, rebuilt and repowered two years ago, will produce strip to 0.015 in. thick. The sendzimir mill will take the 0.015-in. thick, full hard material from the cold strip mill and reduce it in one pass to tinplate thickness.

Also involved in the company's expansion program are structural and design changes in the company's seven open hearth furnaces the completion late this year of a 125-ton oxygen plant—the second largest generator at Granite City Steel—that will provide most of its output for roof lance decarburization in the open hearths; and the installation next year of a second continuous galvanizing line. ▲

The latest development in Open Hearth Steel-making Practice

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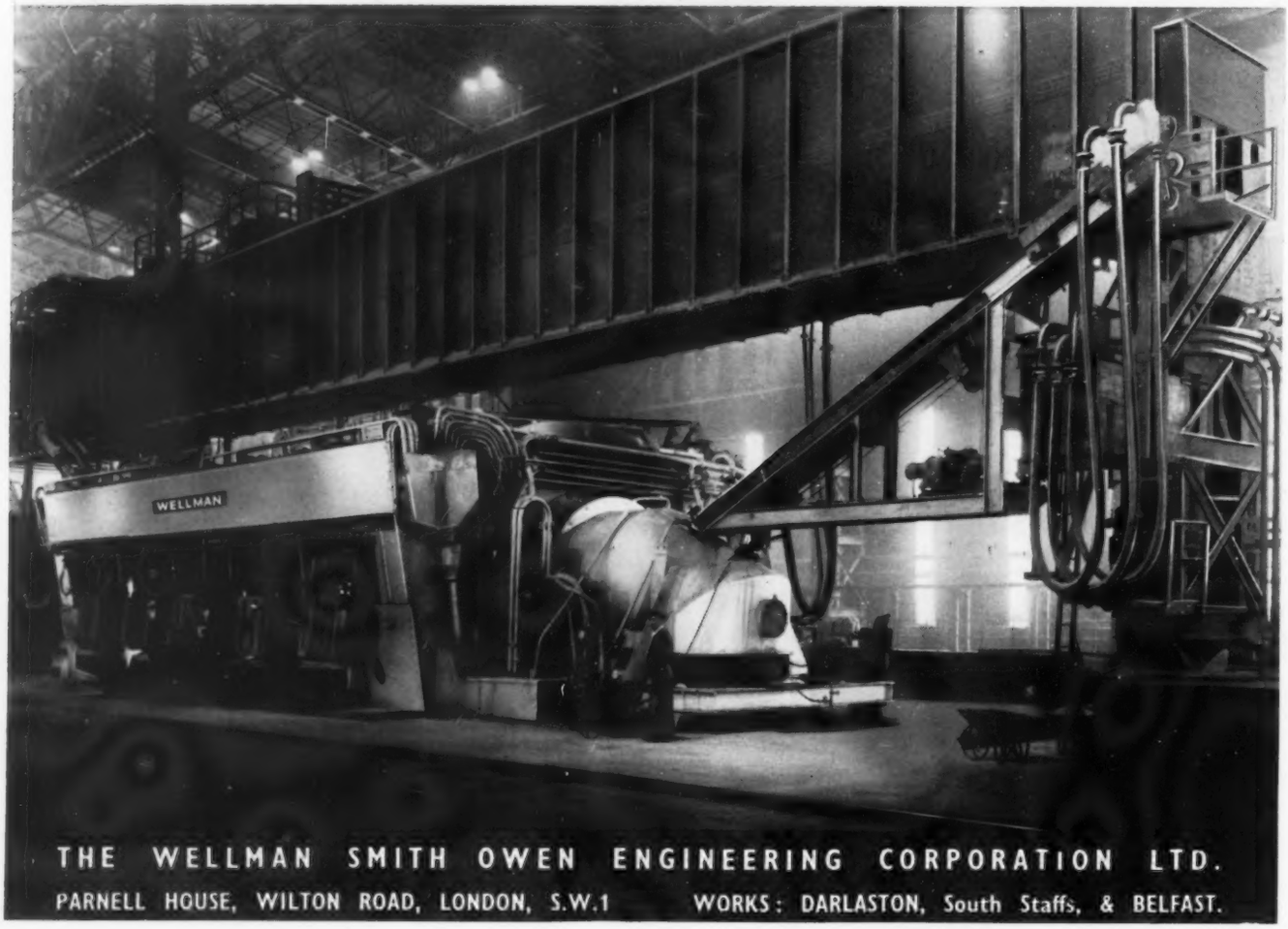
now offer the

AJAX Oxygen Steel-making Operation

This new steel producing technique has been incorporated in the furnace illustrated. It was invented and developed by Appleby-Frodingham Steel Company, and has already produced over 750,000 tons of ingots. A third unit has now been commissioned and a fourth is about to be reconstructed.

Outputs have been increased to over five thousand tons of ingots per week, using 100% phosphoric molten iron.

This Furnace has now over 90% availability together with lower than normal refractory costs.



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New Ceco Mill Rolls Bars Directly from Billet-Size Ingots*

THE first mechanized bar mill engineered exclusively to direct roll electric steel ingots into finished bars is completed and producing successfully at Ceco Steel Products Corp.'s new plant at Lemont, Ill.

The new Ceco plant, which cost about $12,000,000, is a semi-integrated cold metal mill with an annual capacity of 180,000 tons. The rolling mill was designed by Birdsboro Corp., Birdsboro, Pa., in conjunction with Ceco engineers and Rust Engineering Co., Pittsburgh.

A captive mill, Lemont will supply Ceco with about half the steel it needs for making its line of rebars and other building products. It is the company's first venture into basic steelmaking.

Careful planning and good timing enabled Ceco to complete the Lemont plant in 18 months rather than the three years usually required for an operation of this size. Construction was started in May, 1958, and the first heat was tapped 11 months later. In September, 1959, the first ingot was rolled. Full production is expected to be reached late this year.

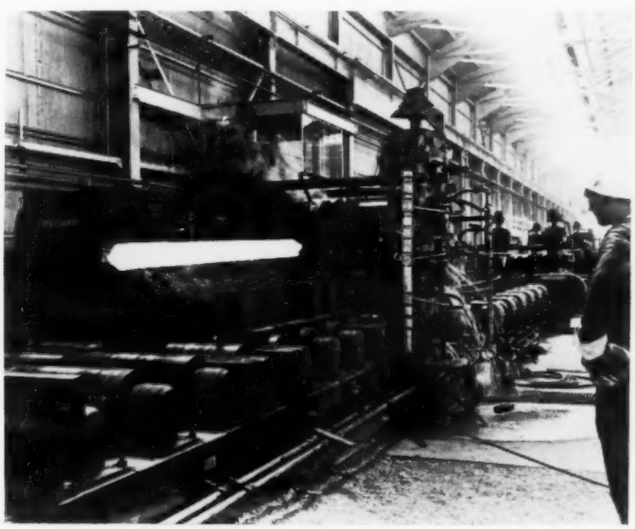
The plant is laid out ideally on an 88-acre tract adjoining a railroad and a ship canal. All materials flow in one direction. Incoming scrap is stored behind the melting shop. Three 20-ton electric arc furnaces supply the molten steel. Ingots are stored in an area between the melting shop and the rolling mill.

The rolling mill facility includes a billet reheating furnace rated at 40 tons an hour. The rolling mill itself, built by Birdsboro Corp., consists of 15 mill stands. These range from a 20-in. roughing stand down to 10-in. finishing stands. Other equipment included are hot and cold metal shears, a 200-ft long mechanical cooling bed, gaging and weighing devices, intermediate conveying tables, bar turning and repeating equipment.

A full length paper on this mill setup is scheduled for presentation at the Rolling Mill Session of the AISE Annual Convention, Cleveland, Ohio, September 28, 1960. It is entitled "Ceco's Ochiltree Works Modern Electric Furnace Bar and Merchant Mill," by W. B. Jacobsen, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and Lawrence S. Barker, Jr., Project Engineer, The Rust Engineering Co., Birmingham, Ala.

Figure 1 — Rolling mill building at Ceco Steel Products Corp.'s new steel plant, Lemont, Ill., is 900 ft long. Plant also has melting shop, several service buildings and storage areas.

Figure 2 — Billet-sized ingot finishes second pass in roughing stand. It will go through 14 more passes before emerging as No. 3 reinforcing rod at end of mill.



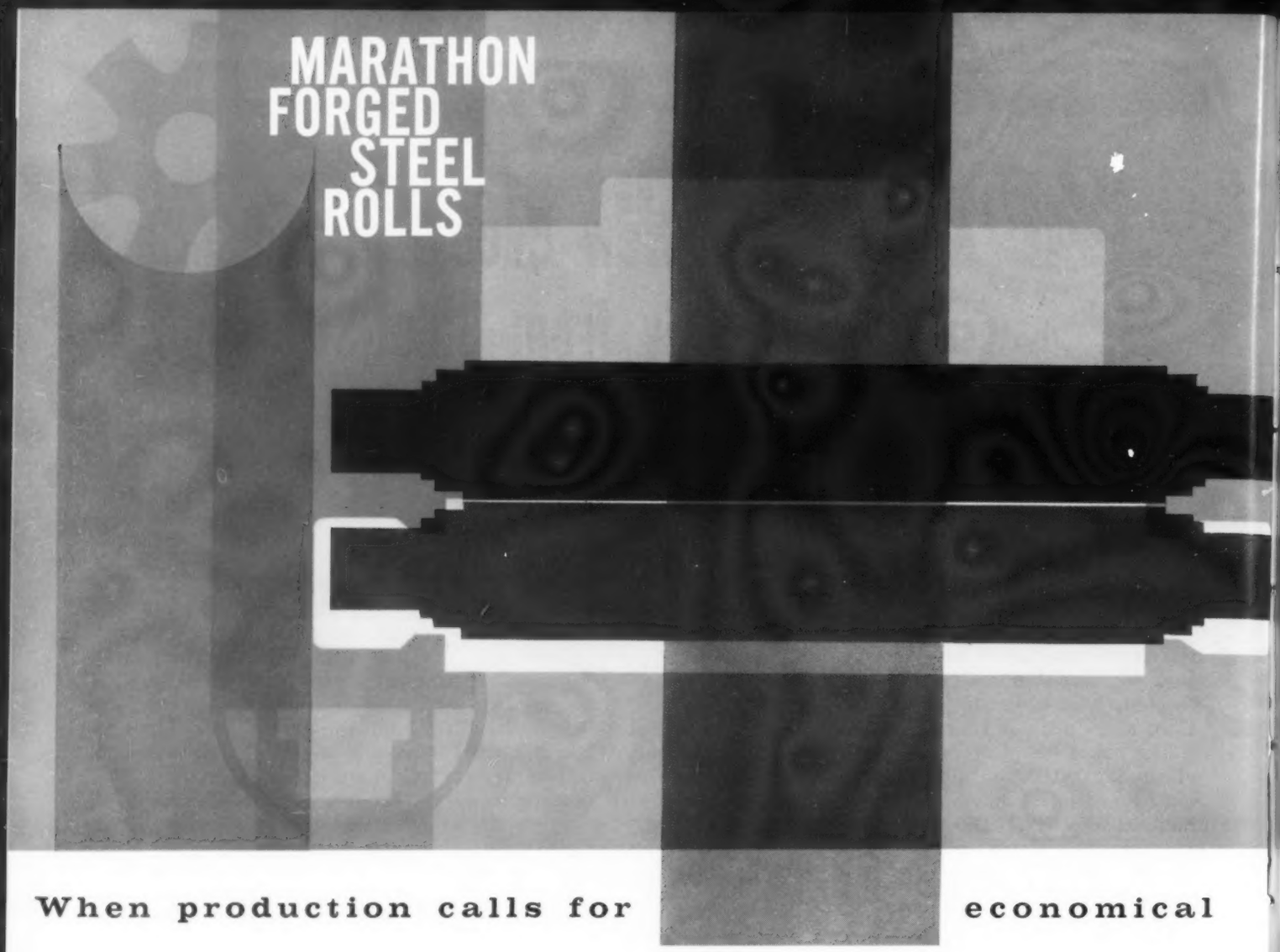


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Figure 3 — Intermediate rolling operations reduce size of bar, increase length. Original 5-ft ingot will eventually be stretched into 481 ft of finished reinforcing bar.

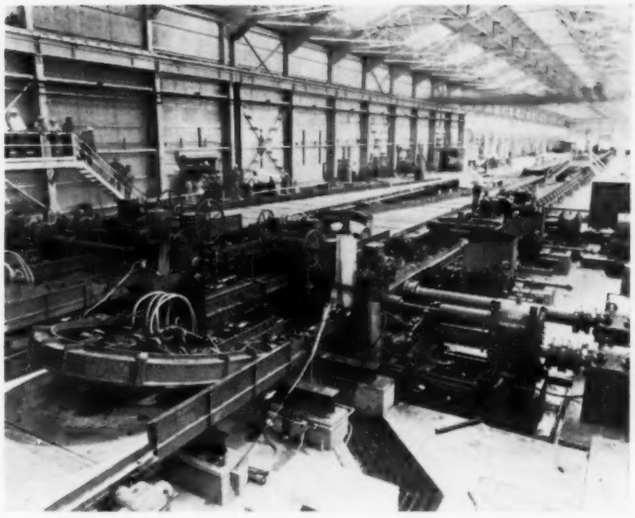


Figure 4 — View of mill shows repeaters in foreground. Transfer tables in background are used for rolling angles and other section.

The bar mill is serviced by three overhead cranes, a complete roll turning shop and maintenance shop. The mill crew consists of only nine men a turn: a roller and assistant roller, three pulpit operators, three mill men and one helper. Because the mill is mechanized, no catchers are needed. Steel in process travels from one end of the 700-ft long mill to the other untouched by human hands. For example, a No. 3 reinforcing rod in traveling from the roughing stand to the intermediate and finish operations goes through 16 passes before completion. Finished products are loaded directly from the end of the mill on to cars.

Already, the 40-ton-an-hour reheating furnace is having a tough time keeping up with the rolling mill. The mill rolled 115 tons of rebar on the second day of operation. Normally, it takes a mill of this size from three to four weeks to produce at that rate.

Ceco's unique, billet-sized ingot design is an important factor in the successful operation of the direct ingot-to-finished-product process. Ingots are cast in six sizes ranging from 322 up to 990 lb. The largest ingot measures $7\frac{9}{16}$ in. x $6\frac{9}{16}$ in. x 6 ft long; the smallest, 5 in. x 5 in. x 5 ft.

With these ingot sizes, the versatile rolling mill is able to produce rebars, angles, rounds and flats with a minimum of roll changes.

It will roll plain rounds $\frac{3}{8}$ to $2\frac{1}{2}$ in. diam inclusive; plain squares $\frac{3}{8}$ to $2\frac{1}{2}$ in. inclusive; deformed reinforcing bars $\frac{3}{8}$ to 2 in. inclusive; flats 1 in. x $\frac{1}{4}$ in. to 4 in. x 1 in. inclusive; angles 1 in. x 1 in. x $\frac{1}{8}$ in. to 4 in. x 4 in. x $\frac{1}{2}$ in. inclusive.

Ceco estimates that 60 per cent of the Lemont mill's production will be in rebar, 10 per cent in flats, and the remaining 30 per cent varying among other shapes.

By operating its own steel mill, Ceco hopes to minimize dependence on outside suppliers during periods of steel shortage. Because the Chicago area is the largest scrap generating district in the country, Ceco foresees no difficulty in obtaining the raw materials it needs to produce its steel.

Location of the mill on the ship canal gives the company a transportation edge on competition. It permits Ceco to ship its products more economically to market areas in the Mississippi basin and Gulf area. ▲

Figure 5 — Reinforcing bar whips through repeaters.

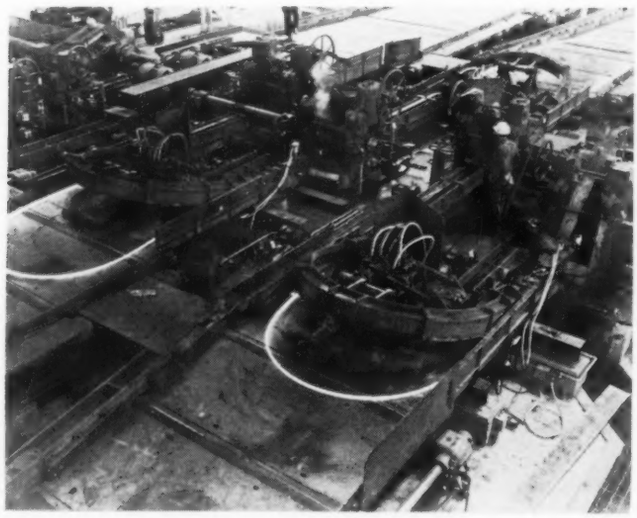
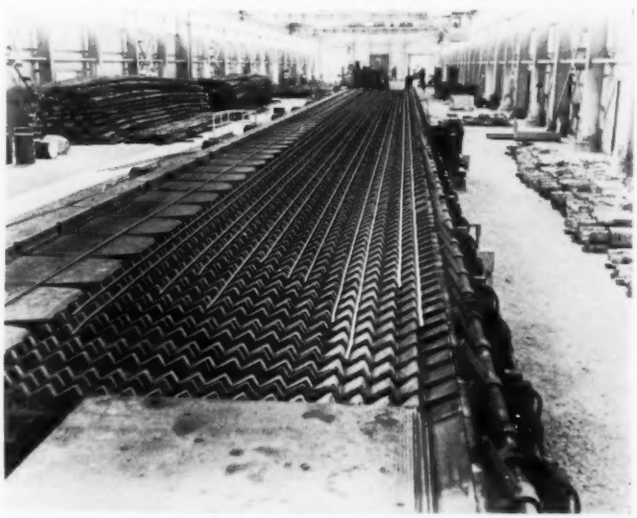


Figure 6 — Reinforcing bars roll onto a 200-ft long mechanical cooling bed before being cut to proper length.



Republic Research Program Studies Staining of Cold Rolled Steel

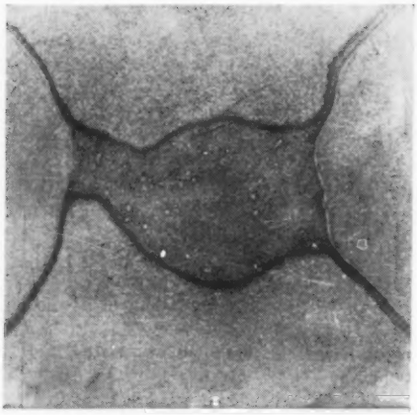


Figure 2 — Laboratory-produced oil stain on cold rolled steel was caused using No. 2 pale oil, oxidized at 100 F. After vapor degreasing the panel, the oil stain boundaries may be observed. Time of exposure was one week.

A METHOD of determining the staining properties of rust preventive oils on cold rolled steel is under development at the Independence, Ohio, Research Center of Republic Steel Corp. According to Republic Steel, a test has already been devised that makes it possible to produce in one week oil stains that would ordinarily take from two months to a year to develop on steel sheets stored in the field.

Calibrations are being assimilated from the tests so that safe storage times can be predicted for a steel coated with any given oil. To date, over 60 different oils have been tested with bromine numbers ranging from 0.0 to over 10.

The availability of data predicting "staining time" should prove of great aid to steel users and producers until such time as chemical and oil companies can develop truly stain free rust preventive oils.

The oil stain test was devised by Dr. Donald E. Babcock, Edwin P. Kawasaki and Keith M. Montgomery, all connected with Republic Steel's new Research Center. The test method they devised consists of first taking cold rolled test panels (approximately 1 x 1¼ in.) that have been vapor degreased, thoroughly scrubbed in a hot caustic solution, washed and dried. A drop of the particular oil to be tested is then applied to one end of the panel. The test panels are placed against the lower side of a ¼ in. quartz plate and held in place with a spring clip. In order to maintain a definite line of contact between the quartz plate, oil, steel panel and air, a piece of light gage nichrome wire is placed between the test panel and the quartz plate, at the opposite end of the test panel from the oil droplet.

The oil on the steel panels is then irradiated with ultraviolet light, held in the beginning at 8 in. above the plate, and the intensity of the light, as the lamp ages, is held constant by varying the distance between the ultraviolet lamp and the quartz plate. The lamp raises the temperature of the steel to about 100 F.

After completion of the ultraviolet exposure the test panels are vapor degreased and inspected for permanent stains which take the identical contour of the line of contact. The length of time for the stain to appear and the magnitude of the stain can be correlated with the severity of the oil stain on steels in storage. Also, there is a correlation between the staining characteristics and the degree of chemical unsaturation of the oil which is indicated by a bromine number determination.

The test should prove a beneficial tool for evaluating the staining properties of any oil presently being used as a rust preventive. It will en-

Figure 1 — Oil stain on cold rolled steel is shown after six months storage. White areas on top of stain are hydrated iron oxide. Lower continuous band depicts oil stain deposit after oxidation has taken place.

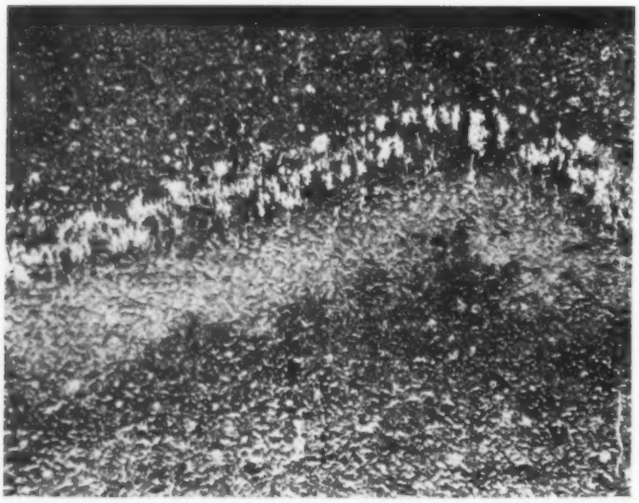
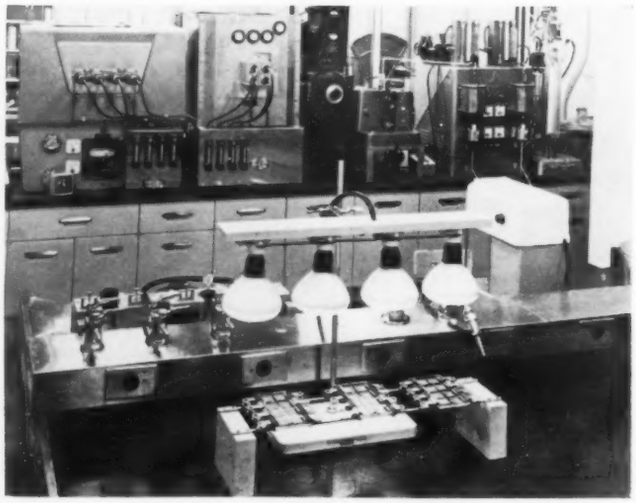


Figure 3 — Laboratory oil stain test apparatus is shown in foreground. Notice oil-air interfaces necessary for staining.



Longer Life! Superior Dependability!

THE ALLEN-BRADLEY LINE of BULLETIN 700 RELAYS IS COMPLETE!

TYPE B general purpose relay shown with 2 N.O. and 2 N.C. contacts. Made with up to 8 poles in various arrangements.

TYPE BX universal relay shown with 4 poles having both N.O. and N.C. contacts. Additional contacts on the 6 and 8 pole relays are N.O. only.

THESE IMPROVEMENTS ARE *IMPORTANT!*

These improved Bulletin 700 Type B and Type BX relays are establishing new standards for relay life and reliability. New design increases mechanical life by *at least 5 times* . . . a new contact motion insures *at least 10 times* greater electrical reliability. Double break, silver contacts never need maintenance, and the new molded coil is impervious to the most severe atmospheric conditions.

These new A-B relays—with their *extra millions of trouble free operations at no increase in price*—are a bargain in the relay field. Write for complete details, today.

NEW ENCLOSURES

for the Bulletin 700 relays are styled by Brooks Stevens—internationally famous industrial designer. Note the "family" resemblance of these enclosures.

NEMA Type 1 for general purpose applications with wrap-around cover for ready accessibility. It has a "quality" appearance.

NEMA Type 4 enclosure for applications that require a watertight and weatherproof seal.

NEMA Type 7 enclosure for NEC Class 1, Group D hazardous gas locations.

NEMA 1

NEMA 4

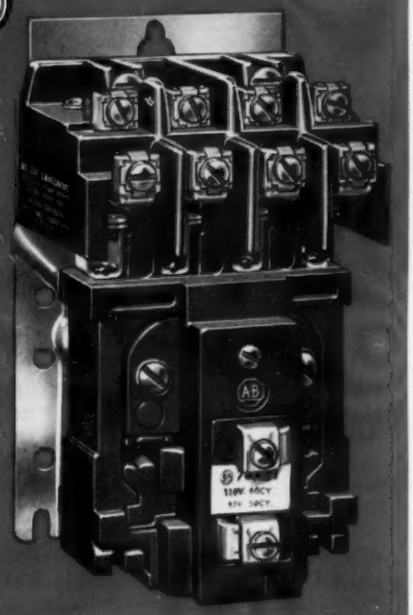
NEMA 7

A-B QUALITY

TYPE BR Bulletin 700 convertible contact relay shown with four poles. Made with up to six poles in line.

No other relay offers such simplicity in changing contacts from N.O. to N.C. (or vice versa)—it takes only 60 seconds!

A four pole unit provides any of the contact combinations otherwise available only with five relays of the fixed contact type. You can reduce your relay inventories. In tests, this relay has *proved* it will provide many millions of trouble free operations. Double break, silver contacts never need servicing. Also, each relay can have one or two complete and full rated contacts added to its base—in the field—without increasing space requirements. If you don't know about the Type BR relay, let's get acquainted.



ALLEN-BRADLEY

Member of NEMA

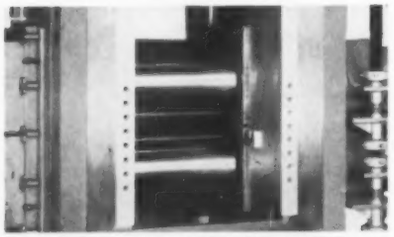
Allen-Bradley Co., 1343 S. First, Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

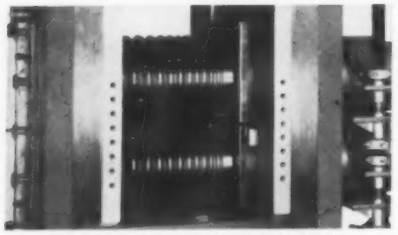
LOMA

COMBINATION ROLLING MILL

4-HIGH STRIP ROLLING SETUP



2-HIGH SHEET ROLLING SETUP



2-HIGH SHAPE ROLLING SETUP

Installed at the General Electric Hanford Works, this 3" & 14" x 20" LOMA 2-High/4-High Combination Rolling Mill offers utmost versatility in the hot or cold rolling of flats and shapes. The machine employs heavy-duty roller bearings of 800,000 lb. separating force capacity, dual motor power screwdowns, motorized roll changing and a 100 H.P. variable speed D.C. drive.

LOMA
MACHINE MFG. CO., INC.
114 East 32nd Street
New York 16, N. Y.

able Republic to evaluate any oil on the laboratory level rather than in field storage where testing is far more costly.

Staining has been a source of trouble throughout the industry whenever cold rolled steel sheets have been held in field storage. The lengths of time for stains to appear vary according to the type of oils used as rust preventives and the conditions under which the steels are stored.

The stain itself shows as a yellow-brown discoloration, and it is difficult to remove or paint over. In most cases steels which have stained have been found unusable for this reason. One of the problems is that when stacked in storage, the sheet stock is quite flexible. The weight of the layers of bundles compresses the individual sheets together, causing an uneven contact between the sheets. The result is heavy and light areas of the rust preventive oils since they tend naturally to collect in depressions or "pool areas." According to researchers, the stain pattern appears to correspond to these heavy and light areas of oil coating. Further, adjacent sheets have the same stain pattern, one being the "mirror image" of the other.

Laboratory tests have confirmed that three things must be present to produce staining: steel-oil-air contact. In the laboratory, for example, even after two weeks or more of testing, no stains appeared on samples for which these three things did not exist. Researchers suggest that this would seem to explain the apparently random distribution of oil stains on stored steel sheets. A stain could be formed where a steel-oil-air contact existed within the stacks, but a uniform coating of the steel with the oil prevents the formation of the oil-air interface between the sheets of steel and thus accounts for the lack of staining under such circumstances.

The degree of staining on laboratory specimens depends upon the length of the test and upon the degree of unsaturation of the oil used. The unsaturation of the rust preventive oils which stained the steel is about twice that of the oils which did not stain. It is felt that the staining phenomenon may be due to the oxidation of the unsaturates in the protective oils.

Originally, it was thought that residual ferrous sulphate on cold rolled steel was catalyzing the staining reaction. To test this theory, ferrous sulphate was applied to panels prior to testing, and the panels were always carefully cleaned to remove any contamination before testing. However, stains of the same magnitude could be produced with or without ferrous sulphate, thus eliminating it as being responsible.

Microscopic observations of the oil stain shows it to be in two phases, beneath which is an actual etching of the steel surface. One is the yellow-brown deposit Republic has identified petrographically as hydrated iron oxide or rust. In the other phase there is a broad white band containing 10 per cent of an anisotropic crystalline aggregate with an index of refraction of 1.45, and the remaining 90 per cent isotropic with an index of refraction greater than 2.11. Thioglycolic acid tests showed that ferric iron was present in the hydrated iron oxide.

Molybdic acid tests showed that no free metal existed over the stained area. The white band adhered tenaciously to the metal and was insoluble in water or in common organic solvents. According to researchers, this white stain, an oxidation product of the oil, is most likely a stable polymer and could only be removed from the steel by another pickling operation.

In summing up, the company, while it is not prepared to report the test method as an unqualified success, points to a number of conclusions regarding the staining itself:

1. Oil stains on steel appear as a result of oil oxidation.
2. The degree of unsaturation of the oil determines the ease with which staining occurs.
3. Oil stains occur along lightly coated oil boundaries, where an oil-air interface exists between layers of steel.
4. Cold working has no connection with oil staining.
5. Laboratory tests failed to disclose any connection between the staining of the test panels and residual contaminants on the steel.

Tests on oil specimens are continuing and efforts at further refining and accelerating the test method will be attempted. ▲

Are you satisfied with your ingot car maintenance costs?

This mark tells you a product is made of modern, dependable Steel.

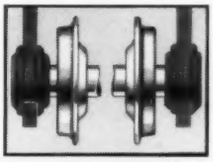
These rugged 8-wheel Ingot Mold Cars haven't had one single repair job since they were bought *six years ago!* Yet they work like new. Each car is designed with an all-welded steel body that offers long life and dependable service. United States Steel has the facilities, the skilled engineers and the technical know-how to build *strong* industrial cars. You give us your specifications and requirements, and we'll design for you the finest industrial cars in the world. We would appreciate an opportunity to discuss this personally and in greater detail. To arrange a meeting write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. or any of our District Offices.

USS is a registered trademark

Here's how USS Industrial Cars are built better:

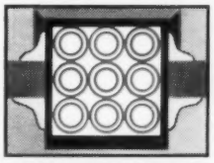
ANTI-FRICTION OUTBOARD BEARINGS:

High-capacity anti-friction bearings are located outside each of the car's eight wheels to minimize sideway and to provide long, smooth-running performance.



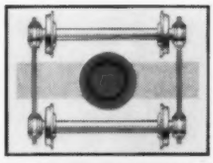
SEVENTY-TWO COIL SPRINGS:

Eighteen coil springs on each side of both trucks provide a total of 72 separate springs for a shock-absorbed level ride.



HIGH ENGINEERING SAFETY FACTOR:

Designed for a 200-ton normal capacity load —including ingots, molds and stools —each car has a substantial built-in safety factor to withstand maximum ingot-stripping thrusts.



OVERSIZE CENTER PLATES:

"Beefed-up" center plates between the trucks and car body are 18 inches in diameter—compared with the conventional 12 inches—to reduce the load per square inch on their surfaces.

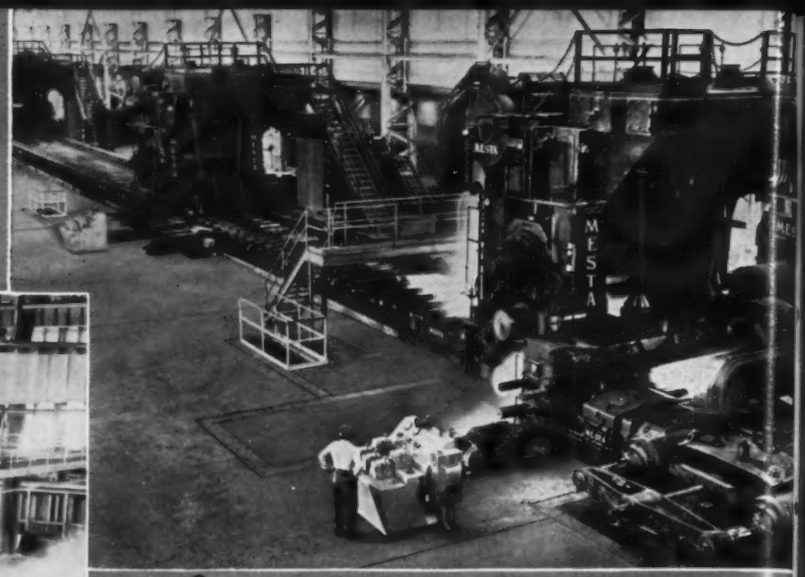
HOT-METAL SHIELDS:

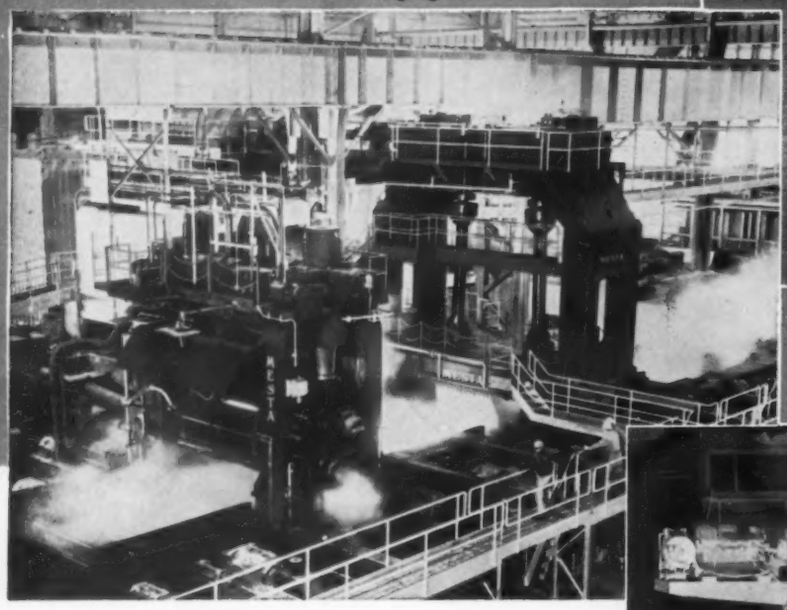
Curved end plates, long side skirts, and special drip shields protect the couplers, bearings and springs from runover molten metal and troublesome solidified drippings.

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

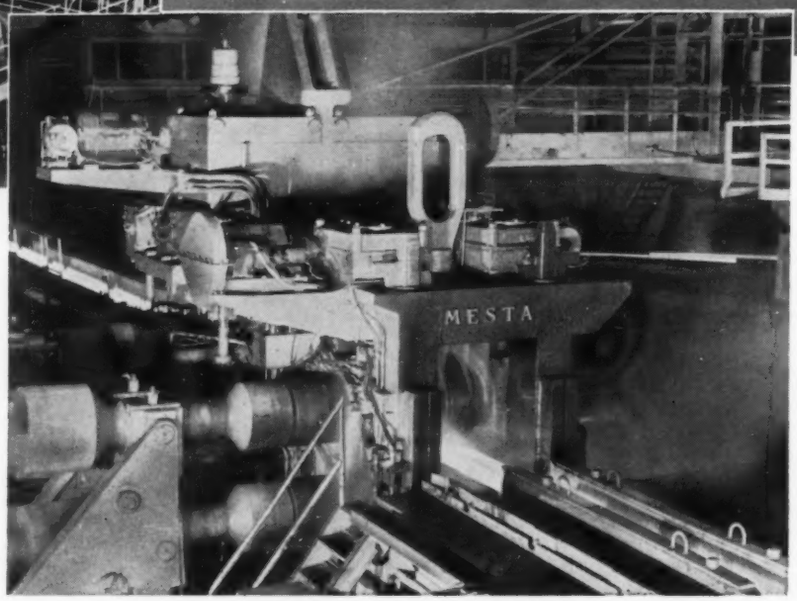
United States Steel

Rolling Slabs and Plates on the MESTA 140" Four-High Reversing Mill and Vertical Edging Mill





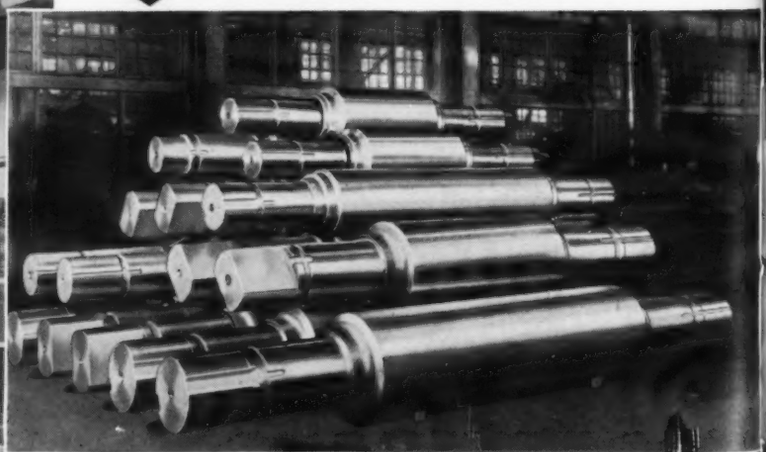
MESTA Continuous Hot Strip Mill Universal Roughing Stands Rolling Strip Steel



MESTA Universal Structural Mill Rolling Wide Flange Beams on the 44" Universal Stand and the 34" Edging Stand

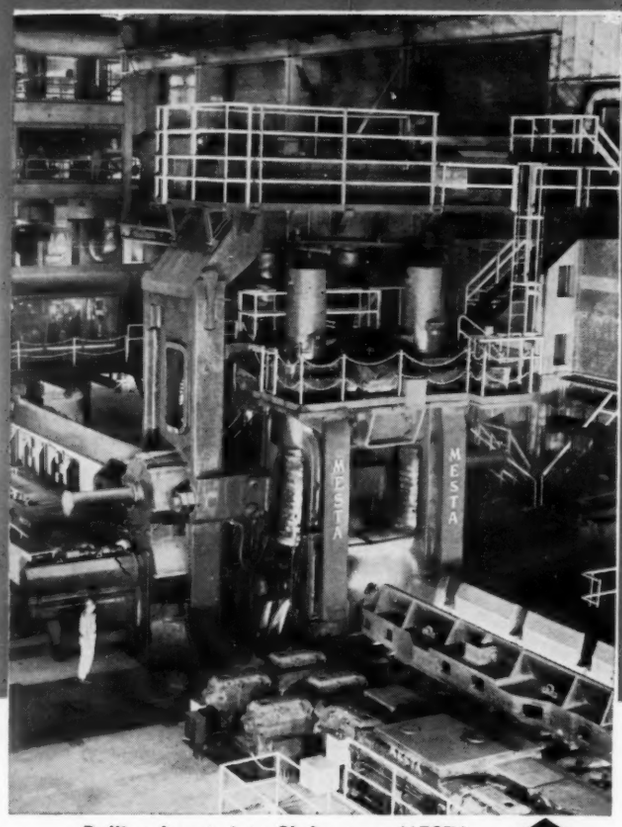
Rolling Strip Steel for Tin Plate in Coils on a MESTA 48" Four-High Five-Stand Tandem Cold Mill.

MESTA Hot Strip Mill Working Rolls



MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA



Rolling Ingots into Slabs on a MESTA
45" x 90" Universal Reversing Slabbing Mill

MESTA

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

ROLLING MILLS FOR FERROUS AND NON-FERROUS METALS

CAST AND FORGED MILL ROLLS

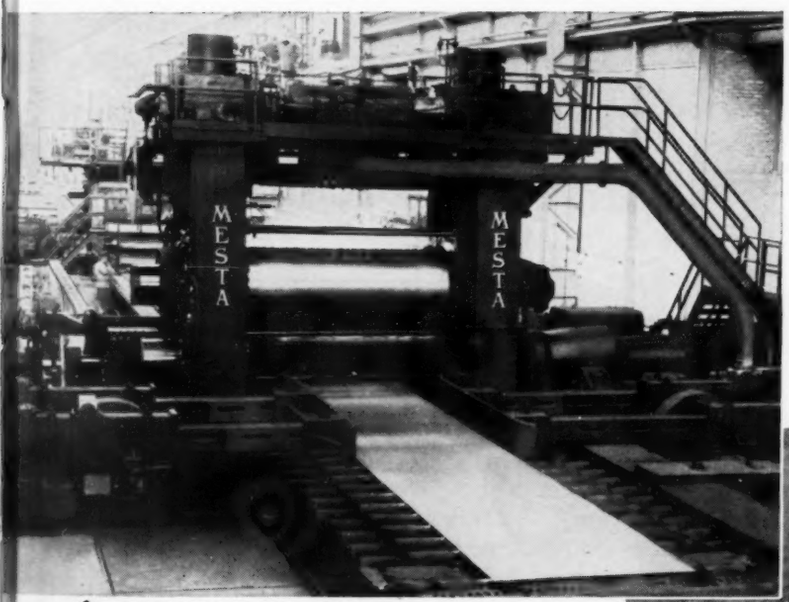
AUXILIARY MILL AND PROCESSING EQUIPMENT

HEAVY DUTY MACHINE TOOLS

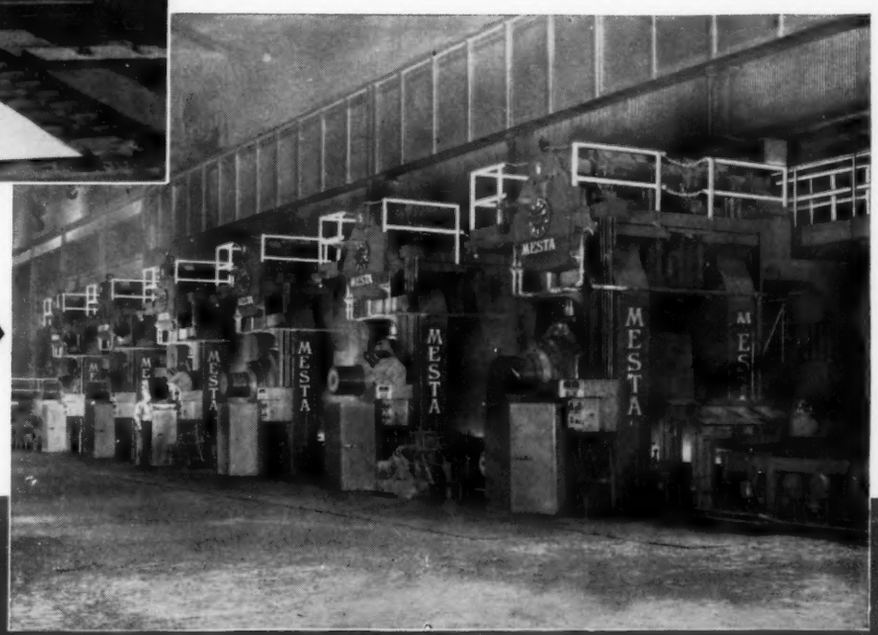
HYDRAULIC FORGING PRESSES

IRON AND STEEL CASTINGS

GEARS • FORGINGS



MESTA 132" Four-High Reversing Plate Mill



Six Finishing Stands with Three Vertical Edgers
on the MESTA 44" Four-High Hot Strip Mill

Wheeling To Increase Production Through Use Of Oxygen

by EDWIN H. JOHNSON, JR.,
Hydrocarbon Research, Inc., New York, N. Y.

IN keeping with its policy of using the latest steelmaking techniques to obtain the most economical production of high-quality steel, Wheeling Steel Corp. is installing a tonnage oxygen plant for use in its Mingo Junction, Ohio, and Steubenville, Ohio, plants.

The plant, designed and constructed by Hydrocarbon Research, Inc., of New York, will produce 420 tons of 99.5 per cent pure oxygen per day. It will be jointly owned by Wheeling and HRI and will be operated by HRI.

Currently, Wheeling is operating two bessemer converters at the Mingo Junction plant, using atmospheric air for blowing. About three miles away, at Steubenville, Wheeling is operating open hearths designed originally to produce 65-ton heats, but currently operating at a capacity of 215-ton heats.

Wheeling's decision to blow the bessemer converters with a mixture of steam and oxygen came after two 30-day trials in the bessemers two years ago, when the process was found to be economically feasible and to upgrade steel quality.

Currently, the bessemer steel is being used almost exclusively in production of pipe because it is high in nitrogen, which gives the steel an age-hardening characteristic, making it unsuitable for many other uses.

The oxygen plant will produce about 400 tons of gaseous oxygen, all to be used by Wheeling. The remaining 20 tons will be in the form of liquid oxygen, which will be supplied by Mingo Oxygen Co., the jointly owned operating company, to outside consumers. Mingo will also produce and sell high purity liquid argon.

Besides production of gaseous oxygen, Mingo will have a 1000-ton reserve of liquid oxygen for use in emergencies, or during shutdowns for routine maintenance of the oxygen plant.

Design of the plant is such that additional units can be added to it to increase its capacity. Current thinking is that one unit to produce another 200 tons will be the first addition, with still another 200-ton unit to be added later.

Design of the oxygen plant is one perfected by HRI and is based on a number of highly successful tonnage installations. Described briefly, compressed air passes through a system of reversing exchangers in which it is purified and cooled and then flows to the base of a high pressure tower. As the air passes through the reversing exchangers, water and carbon dioxide are deposited as solids on the surface of the exchanger, leaving the air charged to the tower clean and dry.

The tower system is made up of an integral high pressure section below and a low pressure section above, and serves to separate the feed air into the desired products by fractionation. Oxygen is withdrawn from the base of the low pressure section and nitrogen from the top. Vapor oxygen and vapor nitrogen thus separated are passed back through the exchanger system where they are warmed by heat exchange with the incoming air.

Refrigeration for the plant is supplied by a nitrogen vapor recompression circuit which uses an auxiliary refrigeration unit. The nitrogen system is unusual in that it uses expansion of nitrogen through turbo expanders.

Plans call for use of the oxygen in the bessemer converters in combination with steam for blowing. It is expected that the blow time will be reduced from the current 12 min. to eight, and that the capacity will be increased from the current 47,500 to 57,500 tons per month using about 178 tons of oxygen per day.

One of the bessemer vessels currently has the necessary equipment for oxygen use in place. Equipment for the other converter is on hand and will be installed in time for the changeover.

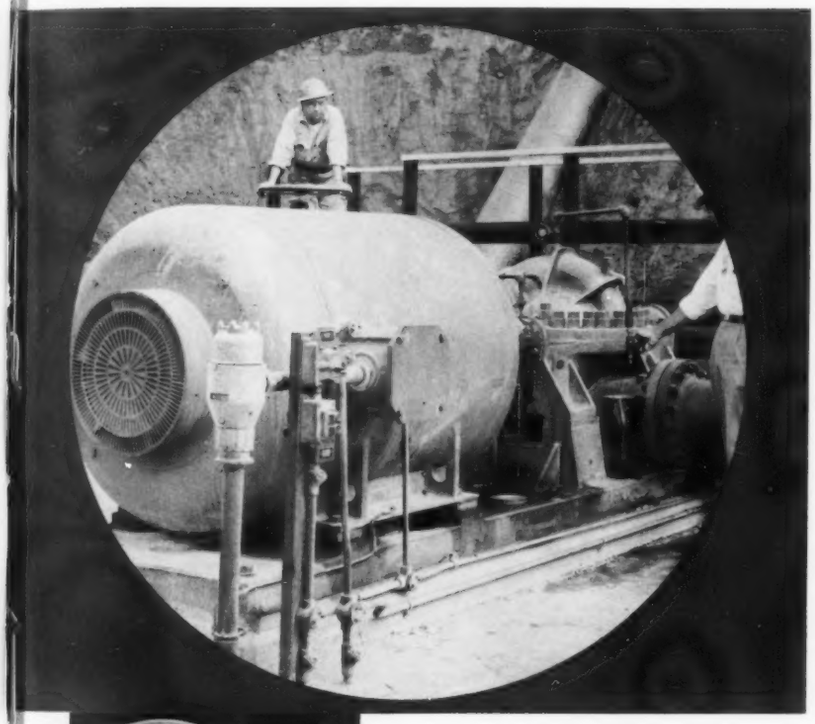
For the open hearths, the oxygen will be piped through a 12-in. pipeline at 200 psi to Steubenville for refining purposes.

The Mingo Oxygen Co. plant will cost about $6,000,000 on completion. It is being constructed on land leased by Wheeling to the company. Wheeling Steel has an option to purchase the oxygen plant at the expiration of the 15-year contract. ▲

Take the "trouble" out of tough jobs... use

WAGNER® BIG JOB-RATED MOTORS

Wagner® Big Job-Rated Motors are all muscle. Power-packed, and with plenty of stamina, they're perfect drives for big pumps, fans, blowers, compressors... any heavy-duty application. When you need big motors that can operate for long periods of time without maintenance... that keep right on producing the power you need even under the most critical operating conditions... choose from Wagner Types RP, YP & ZP Motors. Put into service, they'll solve your large motor problems.

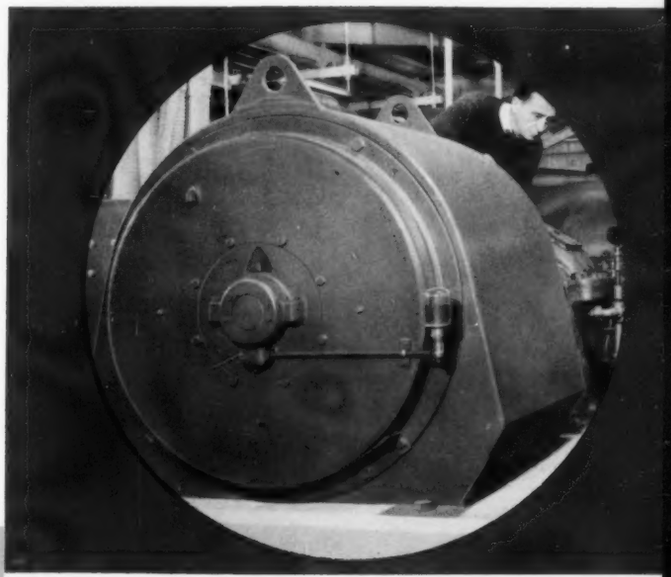


Built in ratings through 500 horsepower, totally-enclosed, fan-cooled YP and ZP Motors are tube ventilated for cooler running, long life. Type YP, standard TEFC, is available with Class A or Class B insulation; Type ZP, explosion-proof, with Class A insulation only. Type ZP can be supplied with Underwriters' Label for Class I, Group C or D, or for Class II, Group E, F, or G locations.

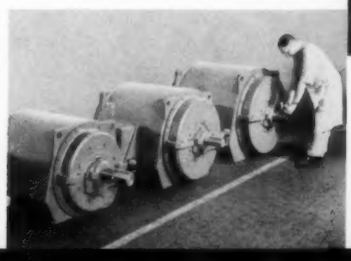
Compact, dripproof RP Motors can be used in many applications that used to require splashproof motors. Their newly designed enclosures resist external damage from corrosion or rough treatment, and prevent penetration of liquids. Windings stay dry, always. Available in ratings from 250 through 1,000 horsepower, Wagner RP Motors meet or exceed NEMA standards for polyphase squirrel-cage induction motors over 200 hp.

For complete information on economical, efficient Big Job-Rated Motors, contact the Wagner branch nearest you, or write for Bulletins MU-230 and MU-232.

Wagner Types YP & ZP Motors have fabricated steel frames that contain a series of tubes through which cooling air is forced by an external blower. Internal blowers, one at each end of the rotor, circulate the warm air inside the motor through ducts in the rotor and stator and around cooling tubes.



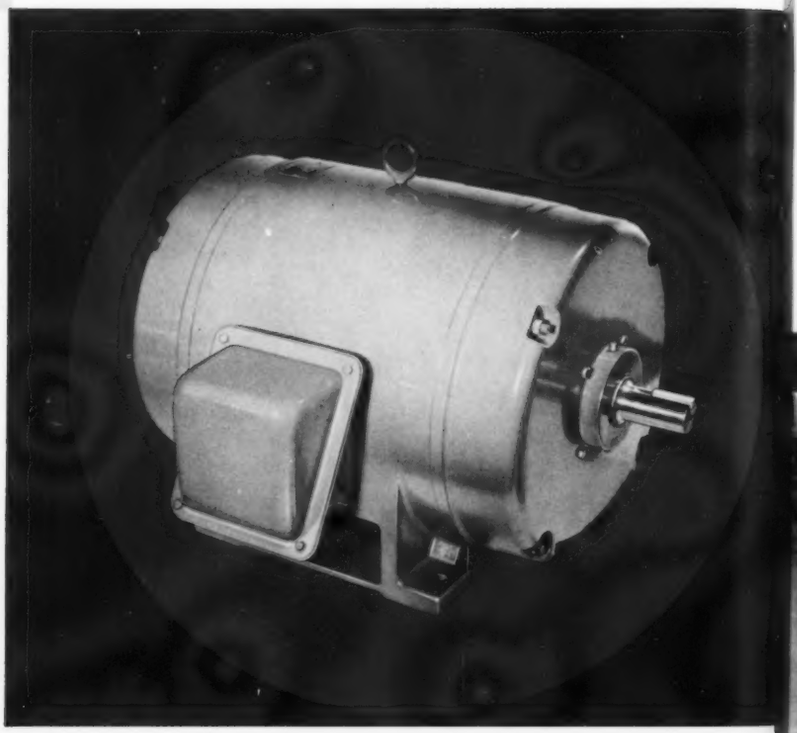
Wagner Electric Corporation
6400 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

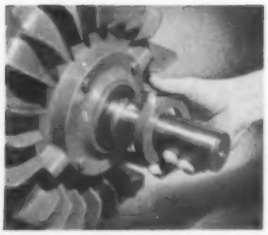


Wagner Type RP Motors have electrical stamina that matches their mechanical ruggedness. They are available in frame sizes 504US through 962S.

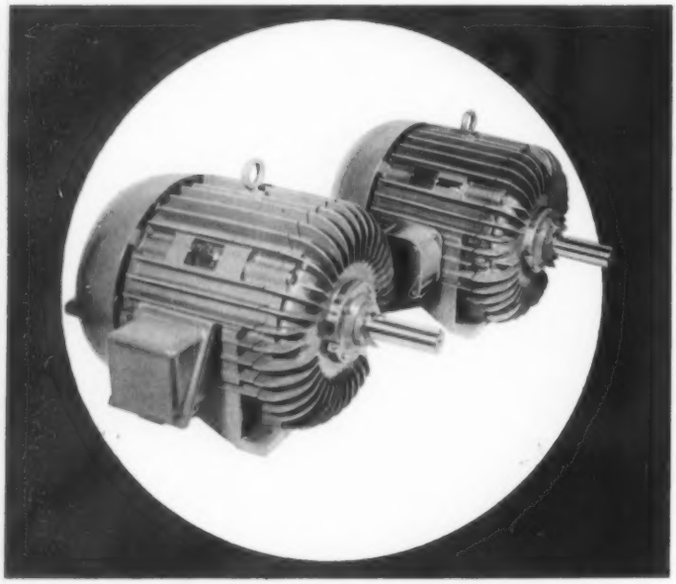
Ease the profit squeeze... cut expensive downtime with WAGNER® PROTECTED-TYPE MOTORS

Wagner DP Motors can't be affected by moisture, corrosive acids, salts, and alkalies. Air intakes and outlets are positioned to provide complete dripproof protection.





Wagner EP & JP Motors are completely protected against dust, abrasives, fumes, steel chips, or filings. Both ends of these motors have running shaft seals to keep the heavy-duty bearings clean.



Wagner® Protected-Type Motors do cut expensive downtime. Keep production rates up, too. For they operate with complete dependability... provide continuous service under the most severe conditions in their specific applications. To top it all, they pack plenty of power into precious little space, are lightweight and long-lived. Simply put... they get the job done.

Wagner Types DP, EP & JP Motors can bring you savings in initial costs, maintenance costs, and in continuity of operation. All three types are built with rugged, corrosion-resistant cast iron frames in NEMA size 182 through 445U. All are designed to meet a wide variety of applications. DP Motors, with their dripproof enclosures, can be used in many spots that once required splashproof motors. Totally-enclosed, fan-cooled EP and JP Motors (Type JP is also explosion-proof) are perfect power packages for automated lines. For complete information on these motors contact the Wagner branch nearest you, or write for Bulletins MU-223 and MU-224.

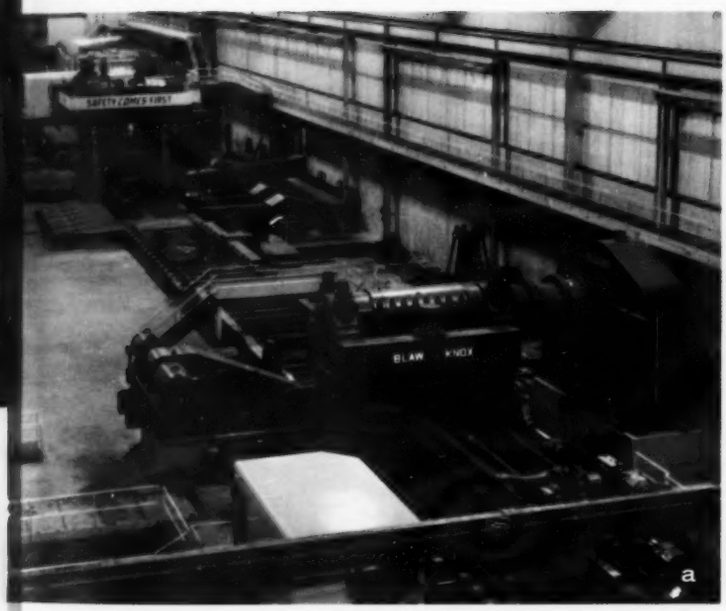
Wagner Electric Corporation

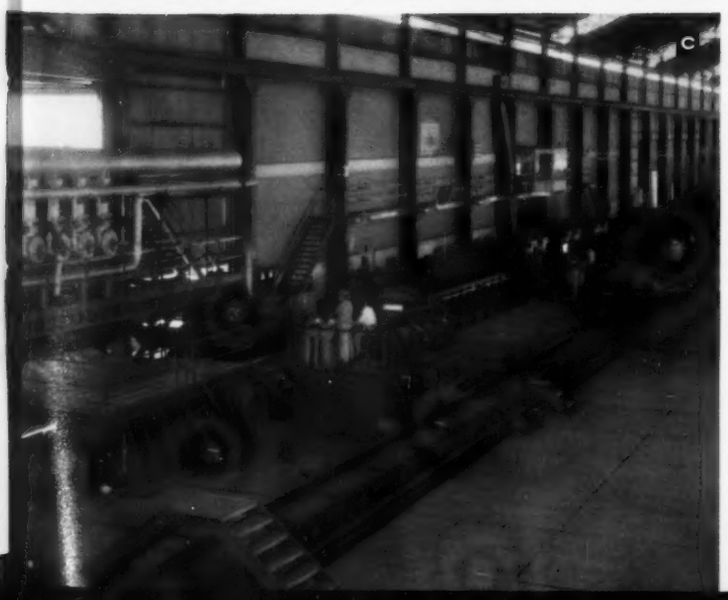
6400 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

WM60-21

Throughout the steel industry, the Blaw-Knox name means exceptional service and the highest standards of performance. Behind this name are the engineering force and plant capacity necessary to meet steelmakers' most advanced requirements for modern automatic equipment. Blaw-Knox Company, 300 Sixth Avenue, Pittsburgh 22, Pa.

BLAW-KNOX





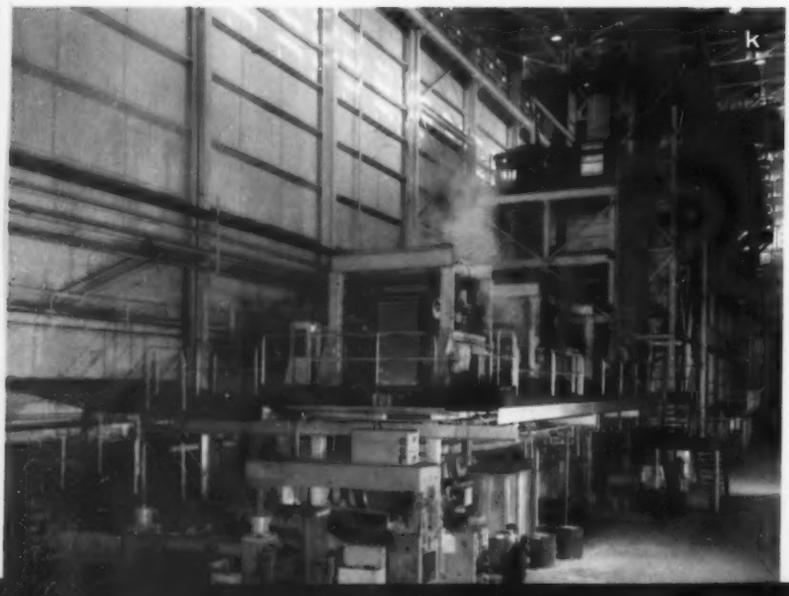
Rolling Mills and Processing Equipment for Shape Rolled Products

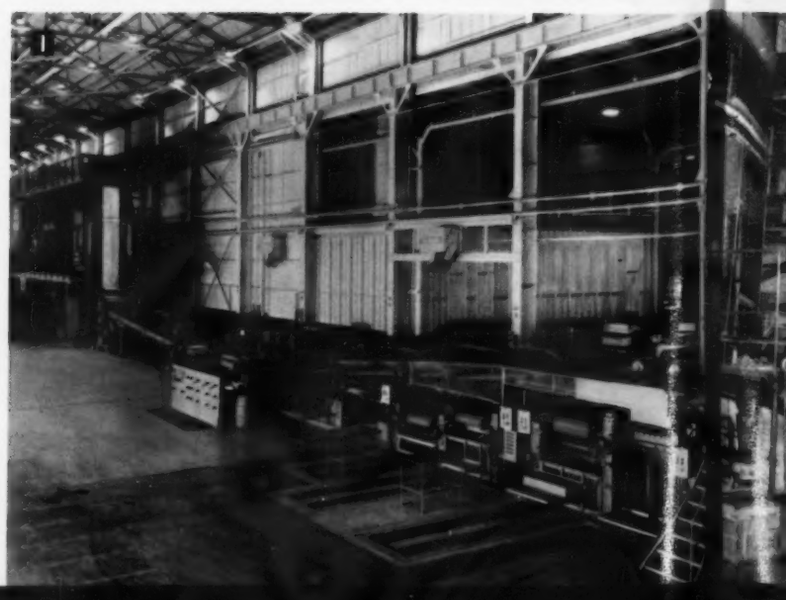
a Combination 46- x 114-inch Blooming-Slabbing Mill and 38- x 53- x 114-inch 4 high Plate Mill. **b** Wide Flange Beam and Structural Mill. **c** Merchant Mill.

Rolling Mills and Processing Equipment for Shape Rolled Products (Continued)

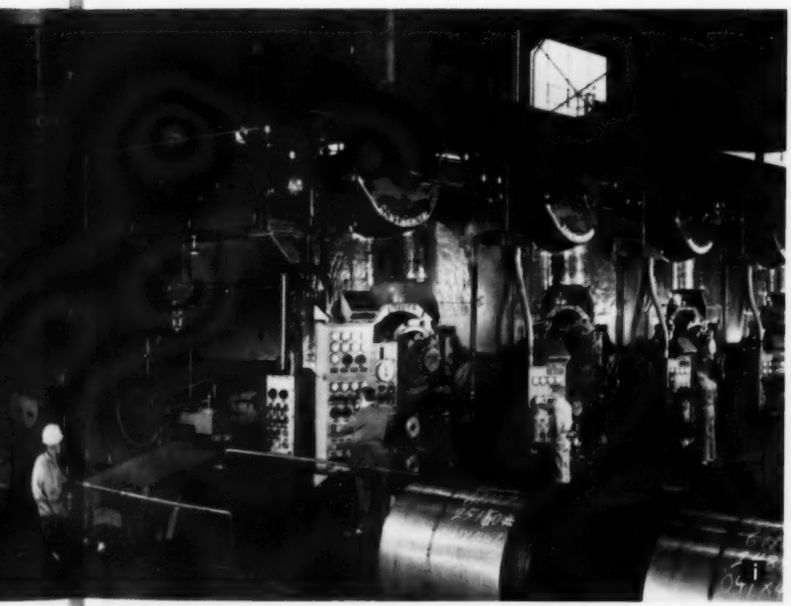
d Continuous Butt Weld Pipe Mill. e High Speed 2-roll Straightener in Cold Drawn Bar Line. f Roller Straightener for Hot Rolled Angles.

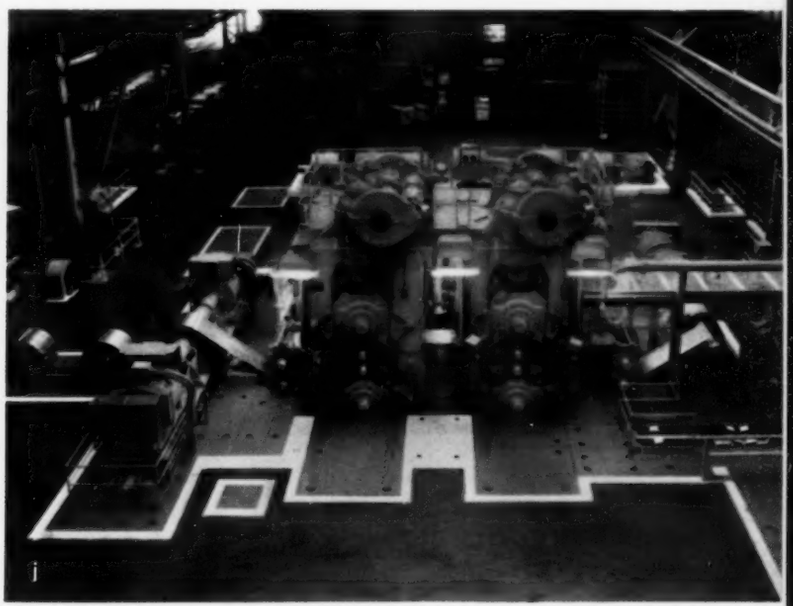
BLAW-KNOX





BLAW-KNOX





Rolling Mills and Processing Lines for Flat Rolled Products

g 46- x 90-inch Universal Slabbing Mill. h 56-inch Hot Strip Mill. i 60-inch Tandem Cold Strip Mill. j 19- and 53-inch x 48-inch Twin Temper Mill. k Continuous Annealing Line. l Electrolytic Tinning Line. m Continuous Galvanizing Line.

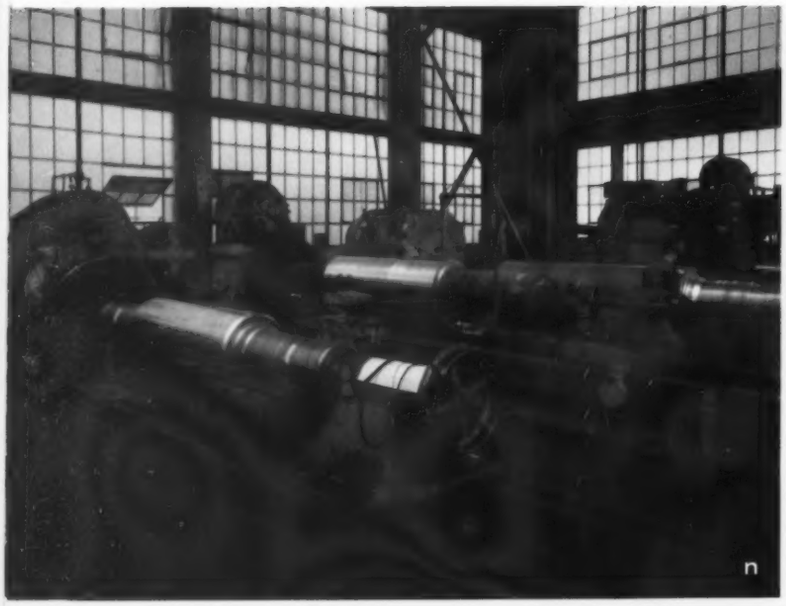
n Iron, Alloy Iron, Steel and Alloy Steel Rolls.

o Foundry Products: Peels, Slag Pots, Charging Boxes, Ingot and Charging Cars, Ladles, Trunnions and Rings, Blast Furnace Hoppers and Bells.

p High Alloy Castings: Radiant Tube Assemblies, Furnace Parts, Continuous Annealing, Conveyor, Feeder, Deflector and Zinc Rolls, and Heat Exchanger Elements.

q Steel Plant Equipment: Ladle Additions Feeders, Autopours,® Dolomite Machines, Water-cooled Doors, Frames, and Reversing Valves.

BLAW-KNOX



HYDRA-JET DESCALING FACILITIES

IMPROVE QUALITY

Meet competition of foreign steel by producing rolled steel products of improved quality by removing the scale, starting with the ingots and redescaling after each reheating of the steel.

COMMERCIAL SHEARING AND STAMPING

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HARMON AND COMPANY

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- ★ **Modern manufacturing equipment**
- ★ **Rigid quality control**
- ★ **Field engineering service**
- ★ **15 completely stocked branches**
- ★ **Fast, dependable delivery**
- ★ **Complete line for all your needs**

New! Robinson Kiln Car and Floor Block. Write for Complete-Line Refractories Catalog.

THE ROBINSON CLAY PRODUCT CO. ESTABLISHED 1836 AKRON 9, OHIO

15 ROBINSON BRANCHES TO SERVE YOU BEST

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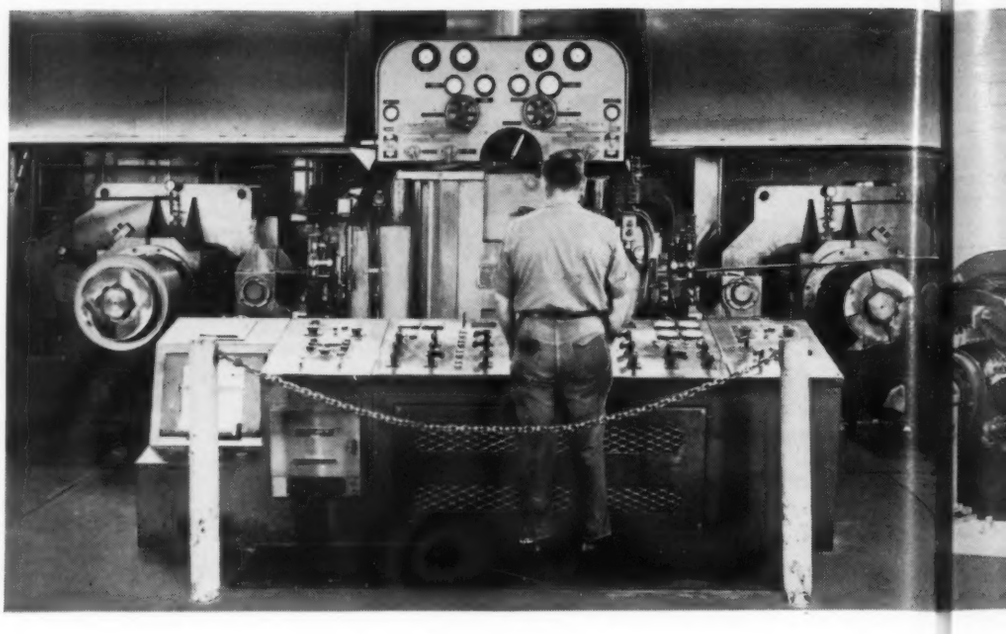
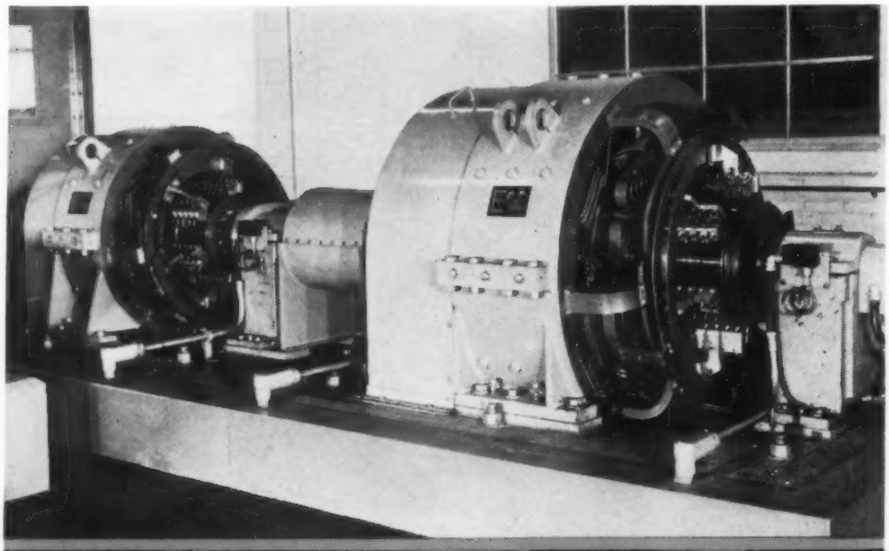
R-359-136B

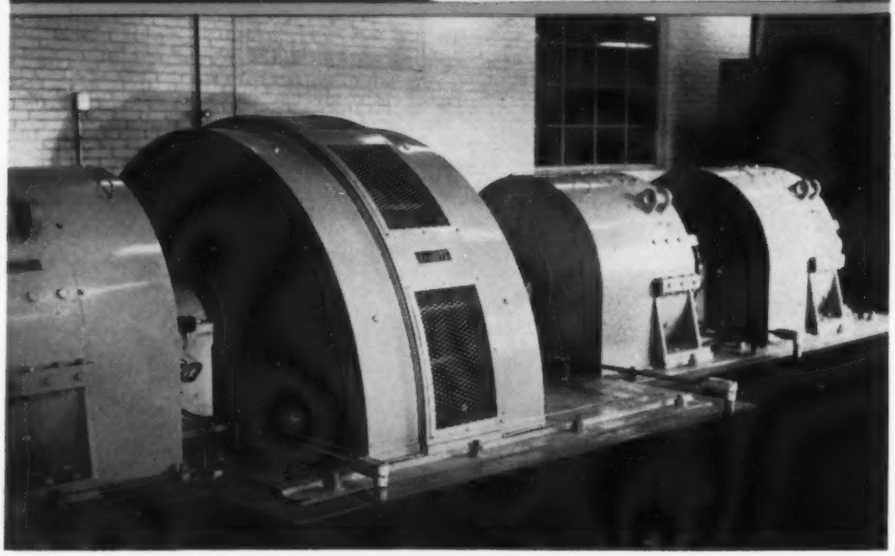


Operator faces control panel of the 26-in. reversing cold strip Sendzimir Mill. Specially designed to roll both high- and low-carbon strip steel to close tolerances, this mill features X-ray gages with automatic control and recording units which assure uniform high quality and extreme accuracy. Elliott engineered the complete automatically-controlled, self-correcting drive.

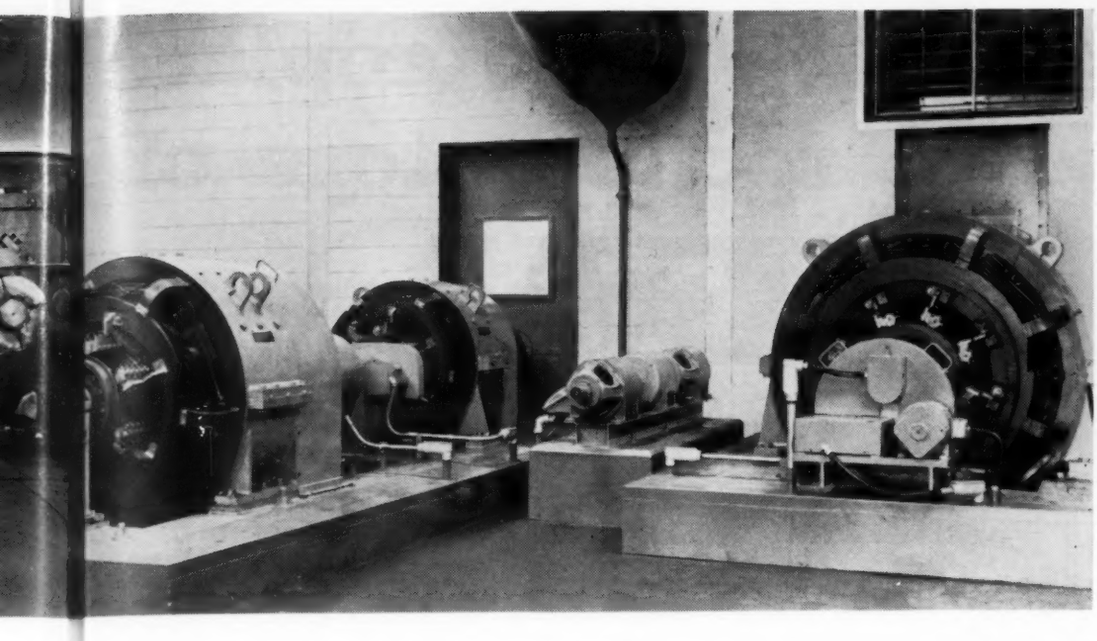
precision·



Close speed regulation and ample power at all loads is assured by the Elliott-engineered drive. The tandem unit shown here powers the left winding reel. The magnetic clutch between the 300-hp motor (left) and the 600-hp motor engages or disengages the larger motor, as required.



The Elliott adjustable-voltage system provides continuous speed adjustment for both the work rolls and the winding reels, from low threading speed up to 1500 fpm. Adjustable voltage is supplied by the four-unit Elliott motor-generator set seen here. Left to right, 1500-kw generator, 3000-hp synchronous motor, and twin 750-kw generators. All main drive machines are built with enclosures for updraft forced ventilation.



At the left is seen one of the winding reel tandem drives which enables the mill to handle a broad range of products. It consists of 600- and 300-hp motors operating at 400/1200 rpm, connected by a magnetic clutch. The main driven rolls are powered by the 1750-hp, 450/850 rpm Elliott Motor at the right.

controlled

The Stanley Works' new Sendzimir Mill at New Britain, Connecticut produces high- and low-carbon strip steel to meet the broadest range of dimensional specifications. Automatic speed synchronization of mill and reels provides strip uniformity and increased yield. Elliott engineered and furnished the complete "tailor-made" drive.

HOW ELLIOTT INDUSTRY ENGINEERING SERVES STEEL AND NON-FERROUS INDUSTRIES

Elliott has engineered complete mill drives and coordinated all associated equipment for virtually every type of mill for leading producers and fabricators.

Bulletin Q-23A describes the wide variety of Elliott experience in mill electrification.

Elliott's versatile, experienced Industry Engineering staff can help you increase production and cut costs.

ELLIOTT Company

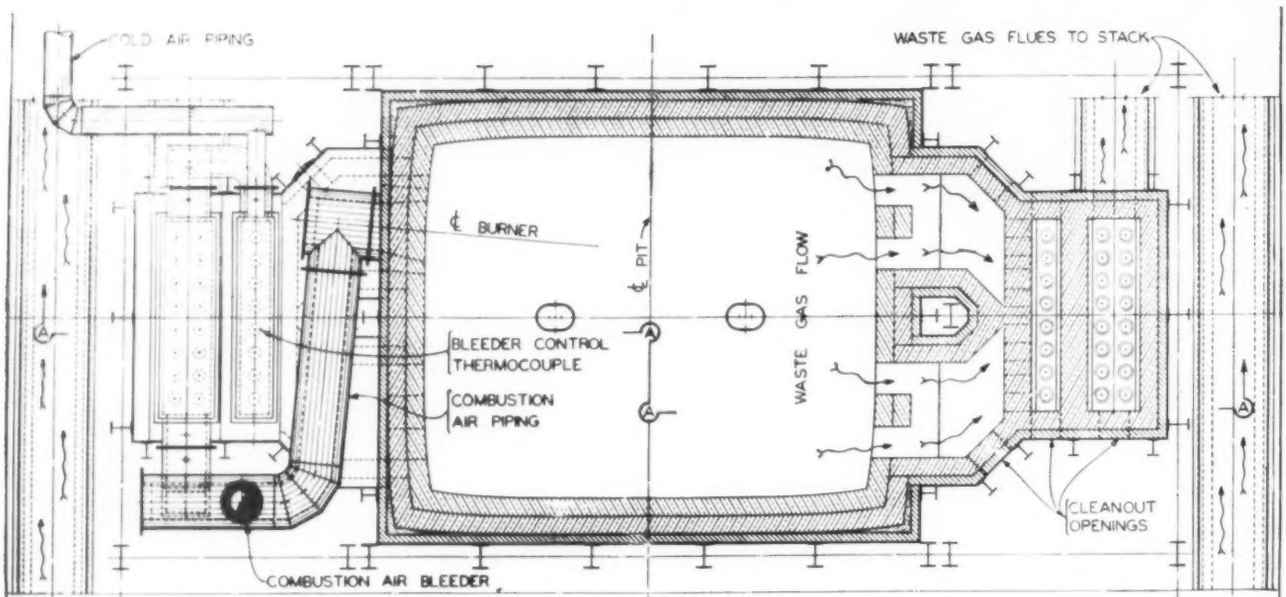
RIDGWAY PLANT RIDGWAY, PA.

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

R10-1

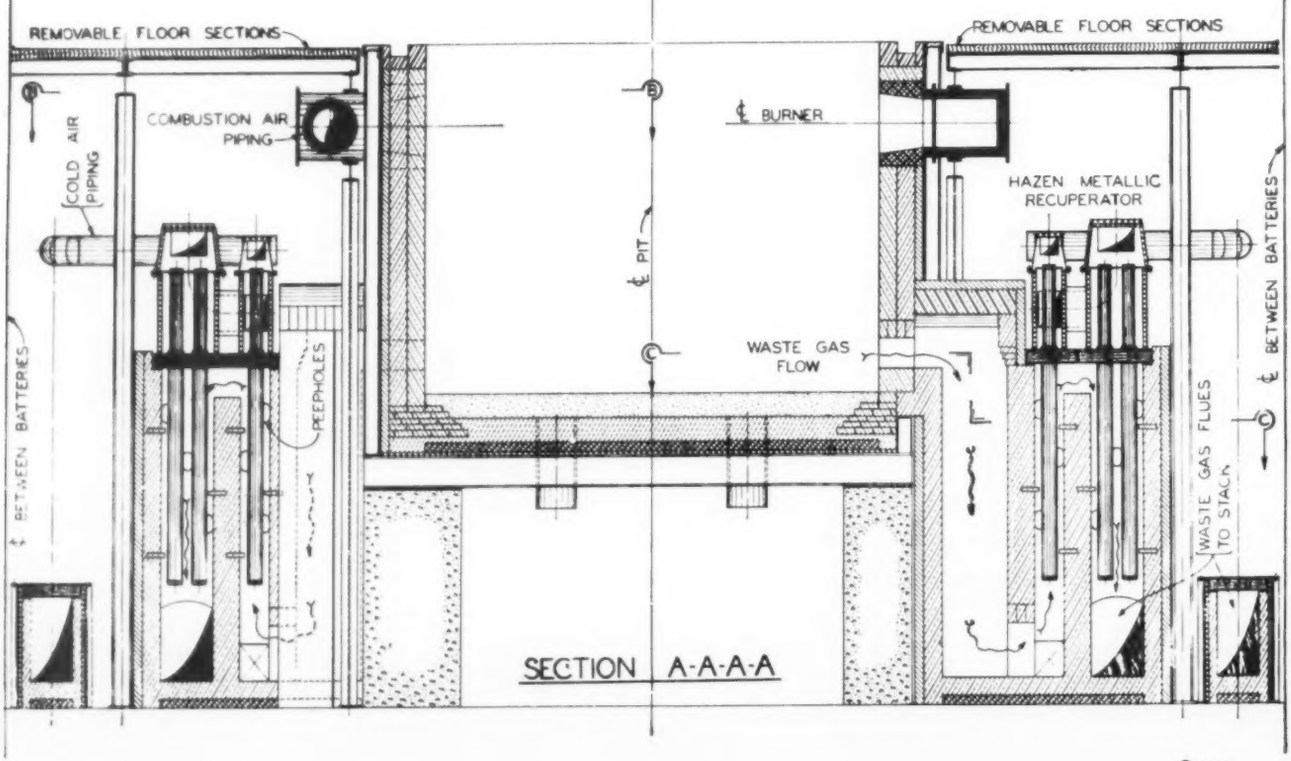
Now Available ... to replace recuperators on

HAZEN *Metallic*



PLAN SECTION B-B

PLAN SECTION C-C



SECTION A-A-A-A

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HAZEN... *the Pioneer in Metallic Recuperator Design and Development*

existing refractory 2-way fired SOAKING PITS

RECUPERATORS

The drawing at left shows application of Hazen metallic recuperators to existing soaking pits and simplicity of installation to replace outmoded refractory recuperators.

Advantages

1. *Hazen metallic recuperators can be installed in approximately same location as now occupied by existing refractory recuperators.*
2. *Hot air is provided to burners with pressure.*
3. *Soaking pit production is greatly increased. This, and also the over-all improvements in heating practice, are explained in our brochure.*
4. *Materials in Hazen recuperators have been successfully developed to withstand the high flue gas temperatures direct from pit.*
5. *Hazen eliminates the need for expensive flues and duct work.*

Nearly 250 successful installations of Hazen recuperators in various types of furnaces are responsible for the trend from refractory to metallic design, to boost steel mill capacity. No other recuperator approaches the Hazen performance record.

Ask for Brochure containing Facts by Metallurgical Heating Authorities

Hazen Engineering Company

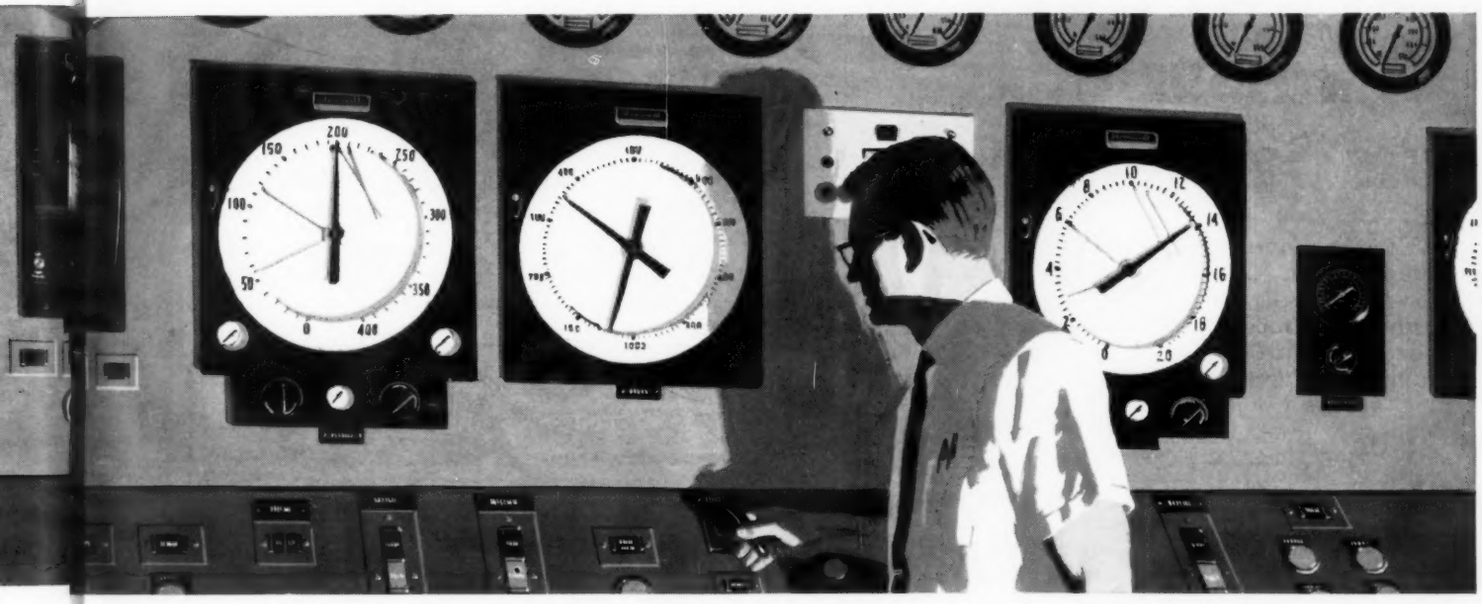
184 Sandy Creek Road (Penn Hills)
P.O. Box 10597, Pittsburgh 35, Pa.

America's Only Designer-Manufacturer of Metallic Recuperators Exclusively

Control your basic oxygen process with

a Honeywell instrumentation system

The new basic oxygen process for steelmaking requires fast, precise, integrated control of all variables—oxygen pressure and flow in particular. Honeywell gives you a *complete system* of instrumentation—from primary elements to computer—tailored to the process and to the individual needs of your mill. This system brings extra advantages to the oxygen process.



Honeywell's application engineers will help you choose the proper components for your process from the broad line of Honeywell products—products proved throughout industry. Honeywell instruments, with electric or pneumatic control, are available for all parts of the oxygen process operation.

The Honeywell all-electric oxygen flow computer measures, records, and controls oxygen mass flow rate—automatically and continuously totalizing the oxygen used for all heats in all converters. The computer compensates automatically for temperature and pressure variations—and delivers the exact number of pounds of oxygen the charge requires.

The Honeywell instrumentation system holds temperature, pressure, humidity, and electrical power at optimum levels at every step of the process—protecting all the equipment—process vessel linings, exhaust gas hood, ducts, and precipitator.

Custom-designed Honeywell systems for the basic oxygen process are now performing in major steel mills across the country. The mills gain Honeywell's unique experience in controlling the oxygen process as well as the assurance of reliable, single-source responsibility for the entire system. Your nearby Honeywell field engineer can give you complete details. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Penna. In Canada, Honeywell Controls, Ltd., Toronto 17, Ont.

75th YEAR PIONEERING THE FUTURE

Honeywell

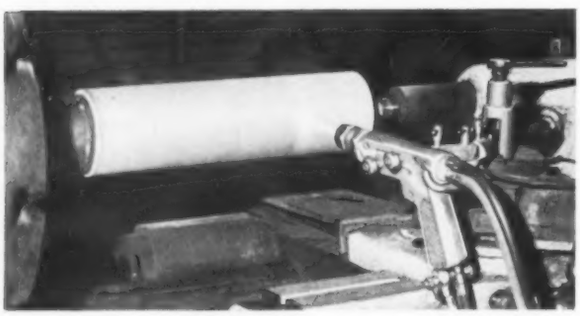
First in Control

HONEYWELL SINCE 1885

SPRAYWELD® Hard Surfacing Cuts Journal Costs

Table roller journal sleeve maintenance costs were cut from $21.06 to only $1.50 each per month through the use of the Colmonoy Spraywelder (reports the September 1957 issue of *Iron and Steel Engineer*). The Spraywelder, a universally accepted powder metal spraying unit, applies Colmonoy hard-surfacing alloys to provide low-cost protection against abrasion, impact, heat, and corrosion.

The Colmonoy Spraywelder sprays powdered Colmonoy alloys to form smooth, even overlays. The overlays are then fused to the part, forming an integral surface of wear-resistant alloy. Write now for complete information about this versatile maintenance tool.



Journal sleeves are made of low carbon seamless steel tubing, with an overlay of Colmonoy No. 6 hard-surfacing alloy, applied by the Spraywelder. The sleeve is rotated in a lathe, with the Spraywelder mounted in a tool-post holder.

HARD-SURFACING & BRAZING ALLOYS

WALL COLMONOY CORPORATION
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Buffalo • Chicago • Houston • Los Angeles • Morrisville • New York • Pittsburgh • Montreal • London, England

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SAVE CONVEYOR BELTS! with a STEPHENS-ADAMSON BELT CLEANER

WRITE FOR BULLETIN 258

Check these features

- Inexpensive, but most effective belt cleaner ever developed.
- Removes wet, dry or sticky material from belt.
- Prevents material from being ground into belt.
- No messy dribble to be cleaned up.
- Will not injure belts or catch on splices.
- No moving parts—requires no drive.
- Easy to install and operate
- Adjustable — fits any size conveyor.

S-A
ENGINEERED BULK HANDLING SYSTEMS
MATERIALS HANDLING PRODUCTS
SPEEDVEYOR® PASSENGER CONVEYORS
STEALMASTER® BALL BEARING UNITS
SPHERCO® BEARINGS & ROD ENDS

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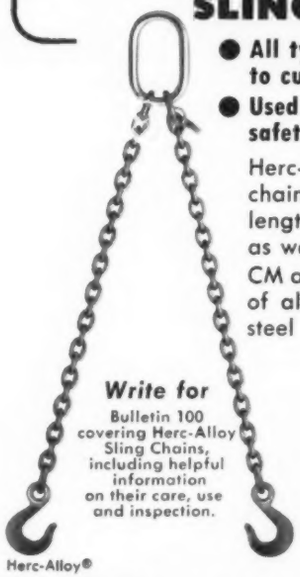
HERC-ALLOY

SLING CHAINS

- **All types and sizes assembled to customers' specifications.**
- **Used throughout industry where safety is paramount.**

Herc-Alloy is the original alloy chain. It is available in running lengths and special assemblies as well as slings.

CM also produces welded chain of all types including stainless steel and bronze.



Write for
Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

Herc-Alloy®

CM CHAIN

COLUMBUS McKINNON CHAIN CORPORATION
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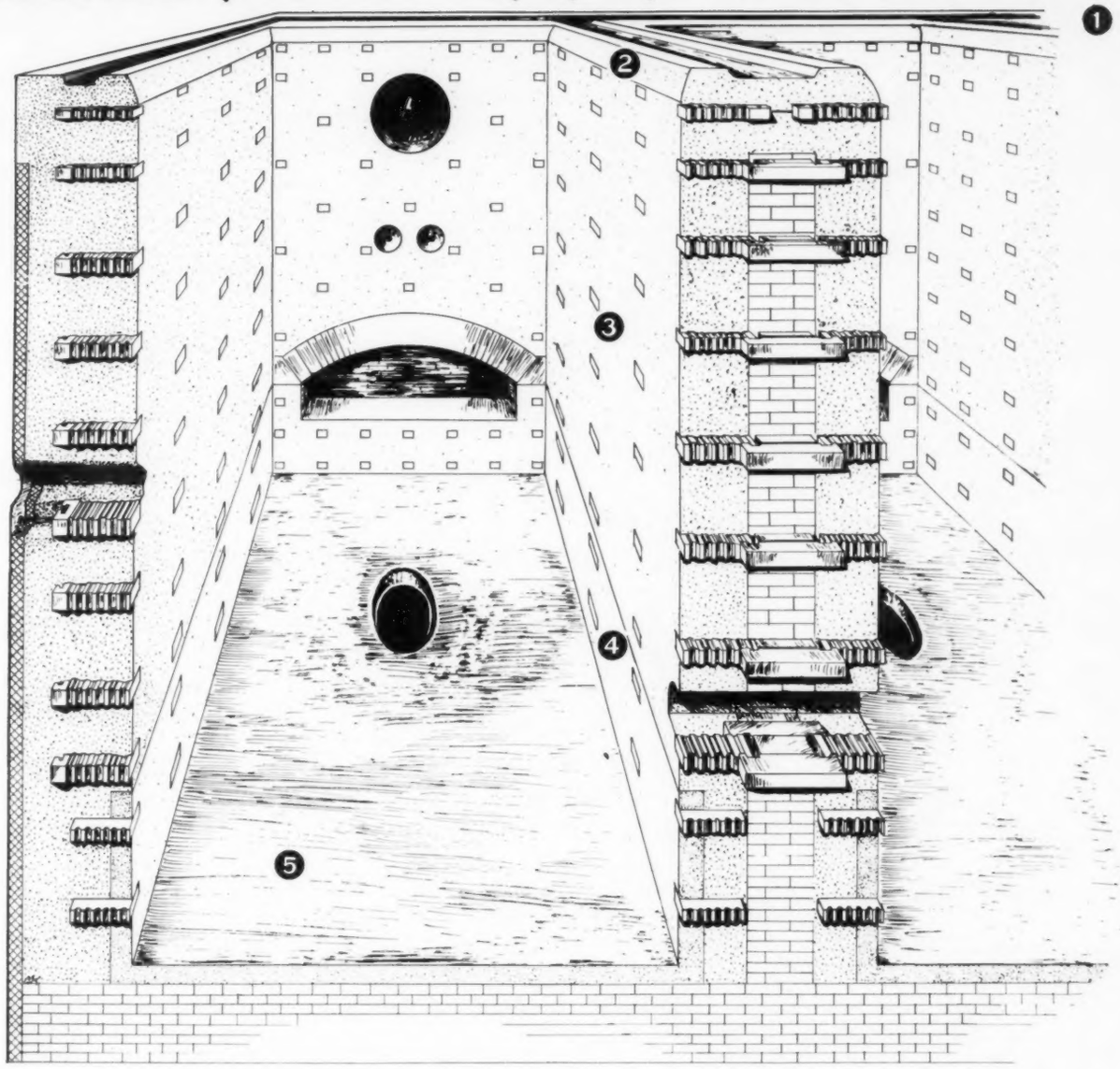
NEW YORK • CHICAGO • CLEVELAND
LOS ANGELES • SAN FRANCISCO

In Canada: McKINNON COLUMBUS CHAIN LIMITED, ST. CATHARINES, ONTARIO

RAMTITE® *proved itself—step by step—from TOP to BOTTOM*



Again proving that *"Repeat orders are the best sign of satisfaction — which is the best endorsement"* — here is a record of RAMTITE progress in soaking pits in leading steel mills.

1. **The original use of RAMTITE *(Special Super No. 25)* was in the covers. (Not shown in sketch.)**
2. **Later, *Special Super RAMTITE* was applied to the coping.**
3. **At another time this same grade of RAMTITE was used in the complete sidewalls.**
4. **The next step was the use of 90-RAM in the slag-line—a more rugged RAMTITE which is so erosion-resistant.**
5. **Now—the latest installation has been 90-RAM on the bottom of this four-hole soaking pit.**

So — servicewise and satisfactionwise RAMTITE has won its place — step by step from the top to the bottom. Another testimonial for this plastic refractory and its monolithic construction. *There is no argument against success!*

Visit our booths Nos. 331-332 at the AISE Iron and Steel Exposition in Cleveland.

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.
1813 S. Rockwell St., Chicago 8, Ill.

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 S. Rockwell St., Chicago 8, Ill.

- ☐ Send folder featuring 90-RAM.
- ☐ Send information about Special Super No. 25 RAMTITE.
- ☐ Please send a representative to discuss RAMTITE.

Company Name_____

Attn. Mr._____ Title_____

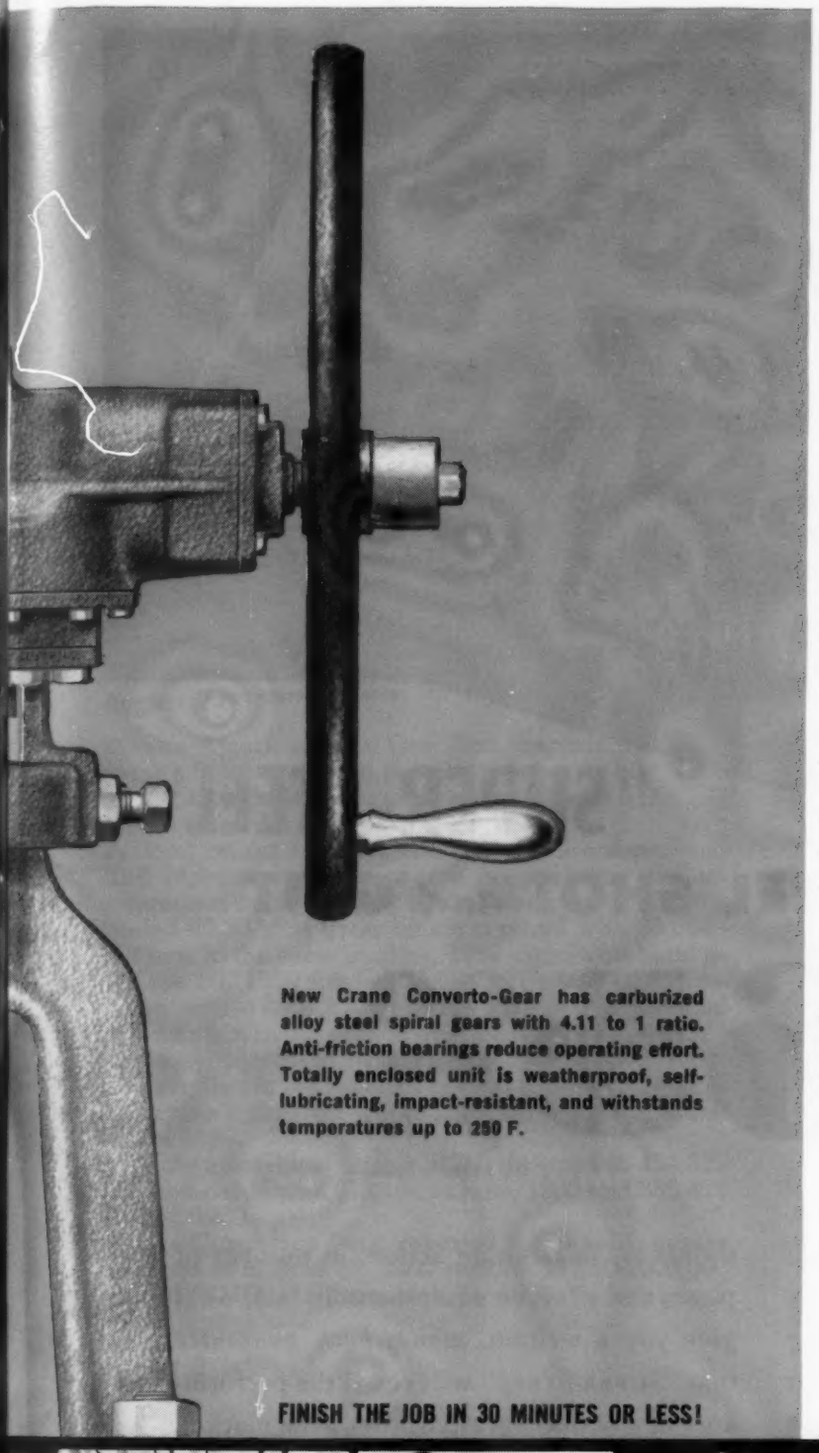
Address_____

City_____ Zone_____ State_____

CRANE
DIRECTION '70

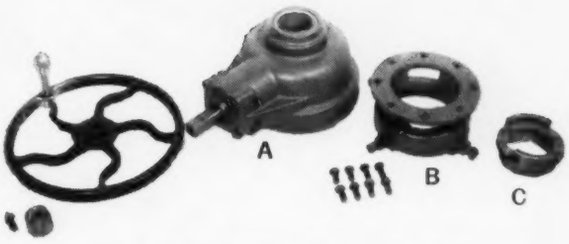
. . . a fast-moving program of planned expansion, product development, and streamlined distribution to help our customers meet the competitive challenges of the Sixties.

NEW! You can order this CRANE Converto-Gear® Valve Operator from stock... install it in less than 30 minutes



New Crane Converto-Gear has carburized alloy steel spiral gears with 4.11 to 1 ratio. Anti-friction bearings reduce operating effort. Totally enclosed unit is weatherproof, self-lubricating, impact-resistant, and withstands temperatures up to 250 F.

FINISH THE JOB IN 30 MINUTES OR LESS!



Only three parts needed to convert your OS & Y valve to gear operation: (a) Crane Converto-Gear Operator, (b) adapter for mounting operator on valve, (c) yoke sleeve adapter. Handwheel and mounting bolts furnished with conversion kit.

Now you can convert to rapid, easy gear operation on many of your Crane iron and steel gate valves without removing them from the line! Changeover is simple and fast with Crane's new Converto-Gear Operator.

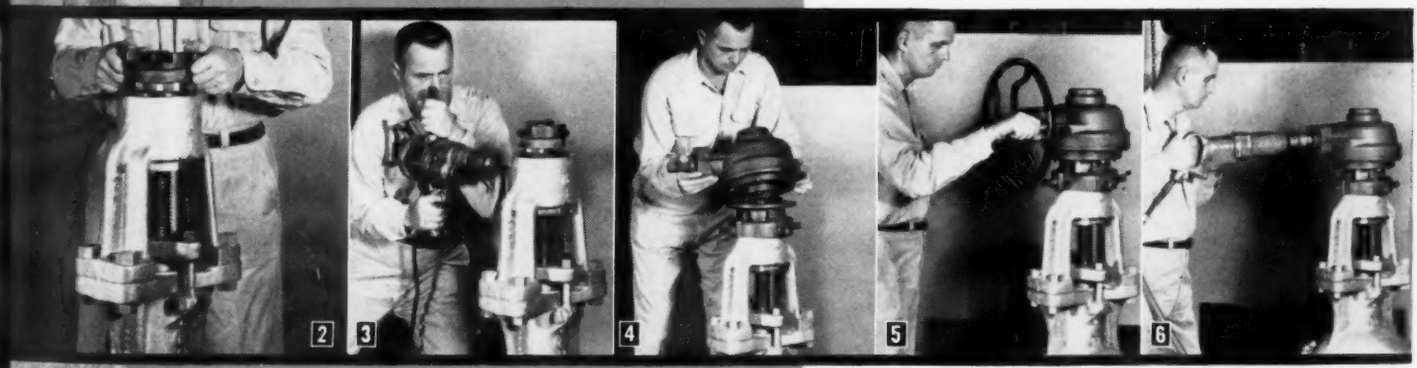
Your Crane Distributor can give you complete information on this brand-new idea in gear operators for gate valves. The Converto-Gear is standard and universal, readily mounted on Crane iron and steel gate valves in sizes from 6-inch to 36-inch, in outside screw and yoke or non-rising stem patterns.

And new orders for gear operated valves can be filled with unprecedented speed because the Converto-Gear can be supplied on valves right from stock. No special yoke castings or brackets are needed . . . just the basic gear operator and a simple two-piece adapter.

CRANE®

CRANE CO. INDUSTRIAL PRODUCTS GROUP
4100 S. KEDZIE AVE., CHICAGO 32

VALVES • ELECTRONIC CONTROLS • PIPING
PLUMBING • HEATING • AIR CONDITIONING
HEAT EXCHANGERS • CYCLOTHERM® BOILERS



To convert your OS & Y valve, (1) remove the handwheel, (2) mount the yoke sleeve adapter, (3) countersink 4 holes for the Converto-Gear adapter, (4) bolt the adapter in place and attach your Crane Converto-Gear Operator, (5) and you're ready for smooth, manual operation, (6) or fast operation with an air or electric power operator.

"SUPER-STEEL"

STEEL SHOT *and* GRIT

$165.00

per ton
in truck loads

A revolutionary new process for producing steel shot makes it possible for METAL BLAST to offer substantial savings to *all plants using steel abrasives.* This new process turns out steel shot much more economically than the conventional process used by others — and savings are passed along to consumers!

"SUPER-STEEL" abrasives are strictly top quality and perform as top quality abrasives should — in cleaning action, in number of passes and effect on equipment. In fact, we'll give you a written, *money-back guarantee* that "SUPER-STEEL" will equal the performance of any steel abrasive now on the market.

Here's an opportunity to save many important dollars on steel abrasives. Why not at least investigate? Write, wire or phone (collect) for full information and sample.

METAL BLAST, INC.

876 EAST 67th STREET • CLEVELAND 3, OHIO • Phone: EXpress 1-4274

ALSO IN: Chattanooga • Chicago • Cincinnati • Dayton • Detroit • Elberton, Ga. • Grand Rapids • Greensboro, N. C.
Houston • Los Angeles • Louisville • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh and St. Louis.

MANUFACTURERS, ALSO, OF TOP QUALITY "SEMI-STEEL" SHOT AND GRIT, MALLEABLE AND CHILLED SHOT AND GRIT — AT COMPARABLE SAVINGS!

Date-line Diary...

August 1

△ Republic Steel Corp. filed a registration statement with the SEC covering a proposed offering of $125,000,000 sinking fund debentures due September 1, 1985. Proceeds, along with funds available under a recently arranged bank credit agreement, will be used to finance a modernization and improvement program estimated to require expenditures of $375,000,000 from 1960 through 1964.

△ The AISI reports that the operating rate of the steel industry for the week of August 1 is scheduled at 1,570,000 tons (55.1 per cent of capacity). This compares with 1,520,000 tons one week ago (53.3 per cent capacity) and 318,000 tons one year ago. Index of production for the week is 97.7.

August 2

△ The American Iron Ore Assn. reports that shipments of iron ore down the Great Lakes in July, 1960 totaled 12,065,190 gross tons compared with 6,855,357 gross tons in July, 1959.

△ Joint report from American Iron Ore Assn. and AISI indicates receipts of iron ore and iron ore agglomerates in the U.S. for the second quarter of 1960, totaled 40,302,584 gross tons compared with 39,664,167 tons in the same quarter, 1959. Stocks on hand as of June 30, 1960 totaled 51,766,707 gross tons compared with 47,791,872 tons on June 30, 1959. Total consumption in the second quarter, 1960, was 28,232,760 tons compared with 34,519,397 tons in 1959, consumption in the first half of 1960 totaled 63,214,278 gross tons compared with 65,569,997 tons in the first half of 1959.

△ Auto assemblies in July, 1960 dropped to 434,377 cars compared with 613,100 in June, 1960 and 555,419 in July, 1959.

△ The Commerce Dept. reported that manufacturers backlogs as of June 30, 1960 stood at $47,500,000,000 down $300,000,000 from May 31, 1960.

August 3

△ USW called a strike against Pittsburgh Steel Co., effective midnight, August 6, in protest against a company plan to cut incentive pay scales. The company countered by starting shut down operations at its Monessen ingot mill, August 4. The company's incentive pay cut plan would have applied to about 23 per cent of its workers, about 1700 men.

△ The Commerce Dept. reported that sales by manufacturers, wholesales, and retailers held steady in June, 1960, after seasonal adjustment, at May's $62,600,000,000 level. Inventories increased $200,000,000 in June, compared with increases of $600,000,000 in May, 1960.

August 4

△ The Edison Electric Institute reported that electric power output in the U.S. last week rose to 14,700,000,000 kwhr, a new record and slightly above the previous week, and 7 per cent higher than the same week of 1959.

August 8

△ The Commerce Dept. reported that construction outlays in July, 1960 dropped, after adjustment for seasonal trends, to $55,500,000,000 down $72,000,000 from June, 1959.

△ The AISI reports that the operating rate of the steel industry for the week of August 8, is scheduled at 1,556,000 tons (54.6 per cent of capacity). This compares with 1,537,000 tons one week ago (53.9 per cent capacity) and 335,000 tons one year ago. Index of production for the week is 96.9

August 9

△ The Agriculture Dept. estimates that cotton production in 1960 will be about 14,471,000 bales, 87,000 bales below the 1959 yield.

△ The Bureau of Statistics reported that Canadian steel production in July, 1960 was 436,840 tons compared with 472,974 tons in July, 1959. Pig iron output in July, 1960 totaled 335,968 tons compared with 352,835 tons in July, 1959.

August 10

△ Armco Steel Corp.'s Sheffield Division at Kansas City, will resume open hearth operation, starting two of four open hearth furnaces, recalling 174 employees furloughed May 21. This will increase Sheffield output to 75 per cent from 50 per cent of ingot capacity.

△ The Bureau of Mines reports that consumption of scrap in the U. S. in June, 1960 totaled 4,479,000 gross tons compared with 5,051,121 tons in May, 1960. Consumption of pig iron in the U. S. totaled 4,692,000 gross tons compared with 5,467,212 tons in May, 1960.

△ The Bureau of the Census reports that production of titanium mill products in June, 1960 totaled 903,620 lb compared with 810,464 lb in May, 1960 and 621,614 lb in June, 1959.

△ Pittsburgh Coke & Chemical Co. reported sales for the second quarter of 1960 totaled $18,696,000, net income $455,000 equal to 31¢ per share, compared with second quarter 1959 sales totaling $22,266,000 net income $1,055,000 or 82¢ a share. For the first half of 1960 sales totaled $34,670,000, net income $1,115,000 or 78¢ per share compared with sales totaling $37,861,000, net income $1,721,000 equal to $1.30 per share in the first half of 1959.

△ The Labor Dept. reported that employment in mid-July totaled 68,600,000,000 an increase of 110,000 over mid-June; unemployment in mid-July totaled 4,017,000, a decrease of 406,000 from the mid-June total.

△ J&L Pittsburgh works was closed by a strike of 300 railroad trainmen, idling 12,000 steelworkers.

△ U. S. Dept. of Commerce, Business and Defense Services Administration reported that world steel production in the first half of 1960 totaled 187,000,000 net tons.

August 12

△ Federal Reserve Board authorized Federal Reserve Banks in New York, Cleveland, Kansas City and Richmond to reduce their discount rates from 3½ to 3 per cent.

August 15

△ Bureau of the Census reports that net shipments of aluminum pig and ingot in June, 1960 totaled 133,847,000 lb compared with 126,142,000 lb in May, 1960 and 181,238,000 lb in June, 1959. Shipments of aluminum mill products in June, 1960 totaled 277,856,000 lb compared with 272,289,000 lb in May, 1960 and 342,018,000 lb in June, 1959.

△ The Bureau of the Census reported that shipments of commercial steel forgings in June, 1960 totaled 110,051 short tons, compared with 110,273 tons in May, 1960 and 140,022 tons in June, 1959.

△ The AISI reports that the operating rate of the steel industry for the week of August 15 is scheduled at 1,589,000 tons (55.8 per cent of capacity). This compares with 1,525,000 tons one week ago (53.5 per cent capacity) and 321,000 tons one year ago. Index of production for the week is 98.9.

August 16

△ The Japan Iron & Steel Federation reports that production of pig iron in Japan in June, 1960 totaled 1,061,500 net tons compared with 1,093,400 tons in May, 1960. Production of ingot steel in June, 1960 totaled 1,952,500 tons compared with 2,018,500 tons in May, 1960.

August 18

△ The Bureau of Statistics reported that Canadian steel output for the week ended August 13 totaled 90,099 tons, (69.7 per cent of capacity), compared with 79,299 tons the previous week (61.4 per cent capacity) and 107,643 tons one year ago.

△ The Commerce Department reported that personal income in July, 1960 increased to a seasonally adjusted annual rate of $407,100,000,000, an increase of $1,000,000,000 over the June, 1960 and $20,200,000,000 over the July, 1959 rate.

August 19

△ The Census Bureau reported starts of private homes in July, 1960 dropped to an annual rate of 1,173,000 units, nearly 10 per cent below the June, 1960 rate.

△ A Union Railroad strike, a U. S. Steel subsidiary, caused by 1200 members of USW stopped steel production at five major Pittsburgh-area mills, causing the layoff of thousands of steel workers.

△ The ARCI reported that deliveries of new freight cars in July, 1960, totaled 3893 compared with 6042 in June, 1960 and 4273 in July, 1959. New orders in July, 1960 amounted to 1306 compared with 321 in June, 1960 and 4159 in July, 1959. Backlog of cars on order as of August 1, 1960, totaled 26,658, compared with 29,555 on July 1, 1960 and 40,309 on August 1, 1959.

△ The AISI reports that the operating rate of the steel industry for the week of August 22 is scheduled at 1,552,000 tons (54.5 per cent of capacity). This compares with 1,558,000 tons one week ago (54.7 per cent capacity) and 332,000 tons one year ago. Index of production for the week is 96.6.

August 22

△ The nation's railroads and 11 non-operating unions representing 550,000 workers reached agreement on a new wage contract. The new contract which calls for a pay increase of 5¢ an hr, and other benefits estimated to be worth 6¢ an hr, will cost the railroads more than $112,000,000 a year.

August 23

△ Manufacturers Trust Co., New York, reduced prime interest rate ½ per cent to 4½ per cent. First Pennsylvania Banking & Trust Co., Philadelphia, announced it will go along with this action.

△ The Aluminum Assn. reports that production of primary aluminum in July, 1960, totaled 177,564 short tons compared with 171,356 in June, 1960, and 179,194 tons in July, 1959.

△ The Bureau of Statistics reported that Canadian steel output for the week ended August 20, totaled 103,664 tons (80.2 per cent of capacity), compared with 90,099 tons the previous week (69.7 per cent capacity) and 107,514 tons one year ago.

August 25

△ Machine tool orders in July, 1960 totaled $32,750,000 down 23 per cent from June, 1960 and down 35 per cent from July, 1959.

△ The AISC reported that shipments of fabricated structural steel in July, 1960, totaled 301,249 tons compared with 332,694 tons in June, 1960 and 238,559 tons in July, 1959. Bookings in July, 1960 totaled 270,198 tons compared with 267,910 tons in June, 1960 and 259,131 tons in July, 1959. Backlog as of July 31, 1960 amounted to 2,203,253 tons.

August 26

△ The Labor Dept. index of consumer prices in July, 1960 average 126.6 per cent of the 1947–49 average, up 0.1 per cent from June, 1960 and 1.4 per cent over July, 1959.

August 29

△ Republic Steel Corp. $125,000,000 debentures are slated to go to the public August 31 via underwriters headed by First Boston Corp.

△ F. W. Dodge Corp. reports that construction contracts awarded in July totaled $3,569,909,000, down 2 per cent from July, 1959. The index (1947–1949 = 100) for July, 1960 is 285, compared with 272 for June, 1960, and 289, for July, 1959.

△ The Aluminum Assn. reports that shipments of aluminum sheet and plate in July, 1960 totaled 121,215,000 lb, compared with 127,216,000 lb in June, 1960. Shipments of aluminum foil in July, 1960 totaled 18,003,505 lb compared with 18,894,474 lb in June, 1960.

△ The AISI reports that the operating rate of the steel industry for the week of August 29 is scheduled at 1,533,000 tons (53.8 per cent of capacity). This compares with 1,547,000 tons one week ago (54.3 per cent capacity) and 332,000 tons one year ago. Index of production for the week is 95.4.

August 31

△ Customer smelters cut their buying prices for scrap copper ½¢ a lb to 25½¢ for No. 2 copper wire scrap.

SEE US AT THE Iron & Steel EXPOSITION CLEVELAND, OHIO Booth 410

ELECTROHYDRAULIC ARC FURNACE CONTROL

SHORTER MELT TIME

. . . for higher yields. Electrode speeds up to 30 ft./min. with safety and stability. Less time to bring electrode down to scrap at start; less time to recover arc after scrap falls away. Rapid short circuit elimination. Less electrode breakage through rapid pull-away on scrap cave-ins.

INITIAL COST REDUCED

. . . as much as 50%. Many components necessary for electric system are eliminated. Extremely simple electrohydraulic system uses a minimum of starters, contactors, rectifier systems, etc.

MINIMUM MAINTENANCE

. . . because hydraulic cylinders eliminate cable changes, gear train maintenance or replacement. No routine maintenance of control panel.

PERFORMANCE GUARANTEE

. . . from the supplier of the most reliable controls to the steel industry for a quarter of a century.

PROVED SUPERIORITY

. . . through the experience of leaders in high-quality steels and specialty metals, who are successfully meeting competition with GPE electrohydraulically controlled arc furnaces. Your GPE Controls representative has list of installations.

Write for descriptive literature

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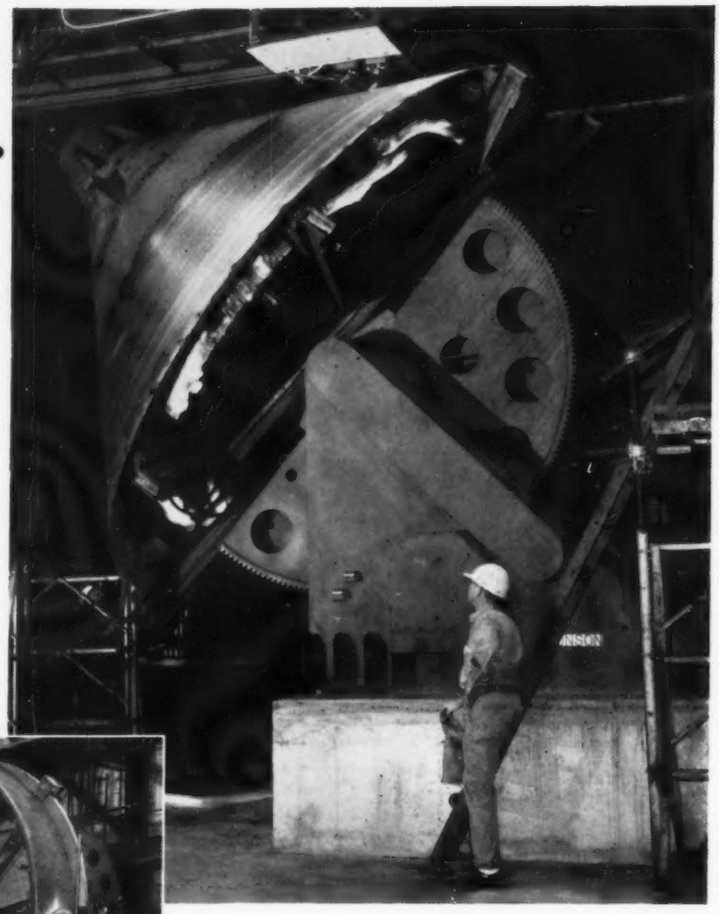
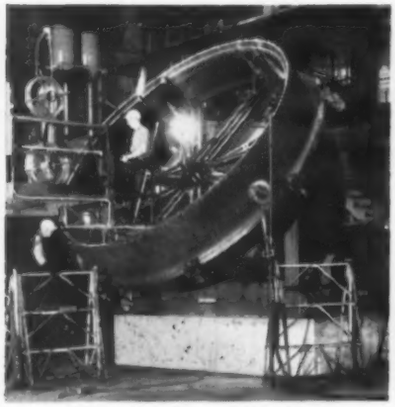
A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

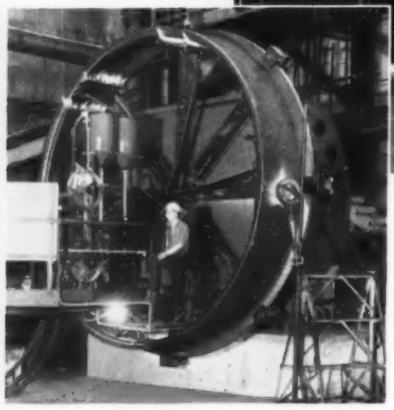
EXCALIBUR...

Welding Positioner 175 TONS CAPACITY

ARONSON Model G3500 "EXCALIBUR" Gear Driven Positioner is used by a large Eastern steel producer for hard-facing bell hoppers for blast furnaces. "EXCALIBUR" provides the greatest precision and economy in the handling of large workpieces.







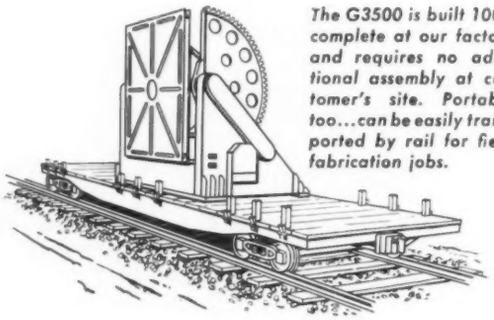
"EXCALIBUR" has been designed to handle almost every kind of weldment at lowest possible shop cost.

"EXCALIBUR" is not physically tremendous, being only 88" from floor to horizontal rotation axis, which allows working both large and small weldments without needing excessive headroom and without working too high above the floor.

"EXCALIBUR" will rotate your weldments as fast as .4 RPM, fast enough for automatic welding down to 8" Dia. and can handle as large a diameter as the factory space permits. It is designed for continuous duty as is encountered when automatic welding hard surfacing jobs where the table may not stop rotating for hours or even for days.

Owning **"EXCALIBUR"** opens production doors to you that are closed to your competitors. It is NOT a special job machine, but a Welding Positioner that will handle 90% of those jobs you now wrestle around the shop floor with the profit-eating crane.

It is quite possible that your capital investment in **"EXCALIBUR"** will be returned in labor and other costs saved in less than three years!



The G3500 is built 100% complete at our factory and requires no additional assembly at customer's site. Portable too...can be easily transported by rail for field fabrication jobs.

Specifications on Request

Quality POSITIONERS by **Aronson MACHINE COMPANY, INC.**

ARCADE, NEW YORK

WELDING POSITIONERS • TANK TURNING ROLLS • TURNTABLES

Photo courtesy Bridgeport Brass Co., Bridgeport, Connnecticut

FOR EVERY APPLICATION, THERE'S ONE CRANE OUTSTANDING...

IN PIPE AND TUBE MILLS . . . Equipped with a double-hook-and-beam lifting arrangement, this P&H overhead crane is one of a number in this plant handling loads of pipe, tubing, and other equipment and material with complete safety. The operator stacks and positions such loads quickly and accurately with no dangerous swaying or twisting.

The installation is typical of the way Harnischfeger job-engineers each crane for a particular application. All factors affecting performance are carefully evaluated and integrated into the overall design. As a result, P&H cranes have established unequalled performance records in every major industry. This is the kind of proven quality that keeps operating costs to a minimum — year after year, decade after decade.

Find out how a P&H job-engineered crane can fit into your materials handling operations. Write today for crane bulletin C-42, Department 125, Harnischfeger Corporation, Milwaukee 46, Wisconsin.

P&H deep carburized gearing as well as bridge and trolley wheels are available as an option where service is particularly severe with frequent impact or shock loads. These two cross-sectional views clearly show how P&H's special heat treatment produces exceptionally hard wearing surfaces combined with a tough ductile core.

Sectional views of deep carburized wheel and gear

P&H
OVERHEAD CRANES

HARNISCHFEGER
Milwaukee 46, Wisconsin

Stub at left shows average waste with conventional cutting carbons; piece at right shows small amount of waste with Kostkutter Rods.

"We save 20 to 25% over conventional cutting carbons with Speer's new KOSTKUTTER RODS*"

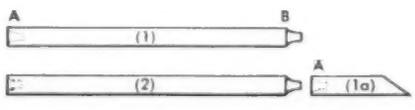
says Benjamin Desper, Cleaning Room Foreman, Atlantic Steel Castings Co., Chester, Pa.

You can save money too! The revolutionary design of Kostkutter Rods, a Speer development, allows the joining of the normally discarded 2½ to 3 inches "waste" to the front of the next rod for further use. Additional savings are realized due to reduced torch damage. It is no longer necessary to economize by burning carbons close to the clamp, bringing the torch too near the hot spot. Additional "left over" carbon is used up with the next rod. This virtually eliminates stub loss. It is important to note that Kostkutter Rods are copper plated (except for the tapered sections) after shaping the rod ends, thereby insuring perfect contact between rods.

Kostkutter Rods are available only from Speer. Buy them in diameters of ½", ⅝", ¾" and 1". Standard cutting carbons are also available at slightly lower prices.

How Kostkutter Rods Save You Money

Each Kostkutter Rod has a tapered hole in one end (A) and a tapered projection at the other end (B) as shown in Diagram 1. The rod is clamped into the torch and used in the normal way. The stub end (Diagram 1a) which, with conventional cutting carbons would be wasted, is removed from the torch and attached to the end of a new Kostkutter Rod (Diagram 2). The tapered end of the new rod slips easily into the tapered hole at the end of the stub and is held firmly by friction. The new rod, with the stub attached, is then clamped into the torch and practically the entire stub is used up instead of being discarded.



SPEER Carbon Co.
Carbon Products Division • St. Marys, Pa.

*Patent applied for

THIS IS AN AAF AIR FILTER*

that can never get to COLUMBIA-GENEVA'S electrical equipment

Dust and dirt—the arch enemies of steel mill electrical equipment—don't have a chance at U. S. Steel's new Columbia-Geneva Division Mill at Geneva, Utah. AAF was called on to make sure of that.

Six different types of filters were required to handle all the clean-air needs at Columbia-Geneva. AAF is uniquely able to meet *all* air-cleaning needs because only AAF makes *all* kinds of air filters. Ask your local AAF representative for Bulletin 518 or write us direct. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Kentucky.

*AAF Roll-O-Matic renewable-media air filter.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

FOR QUALITY... PRODUCTIVITY ... PROFIT

INTEGRATED AUTOMATION BY GENERAL ELECTRIC

G. R. BROWN, Manager of General Electric's Metal Rolling and Processing Sales, talks about new automation capabilities at General Electric.

Integrated Automation

"General Electric is ready now to assist you with the ultimate in automation . . . automation of your entire plant."

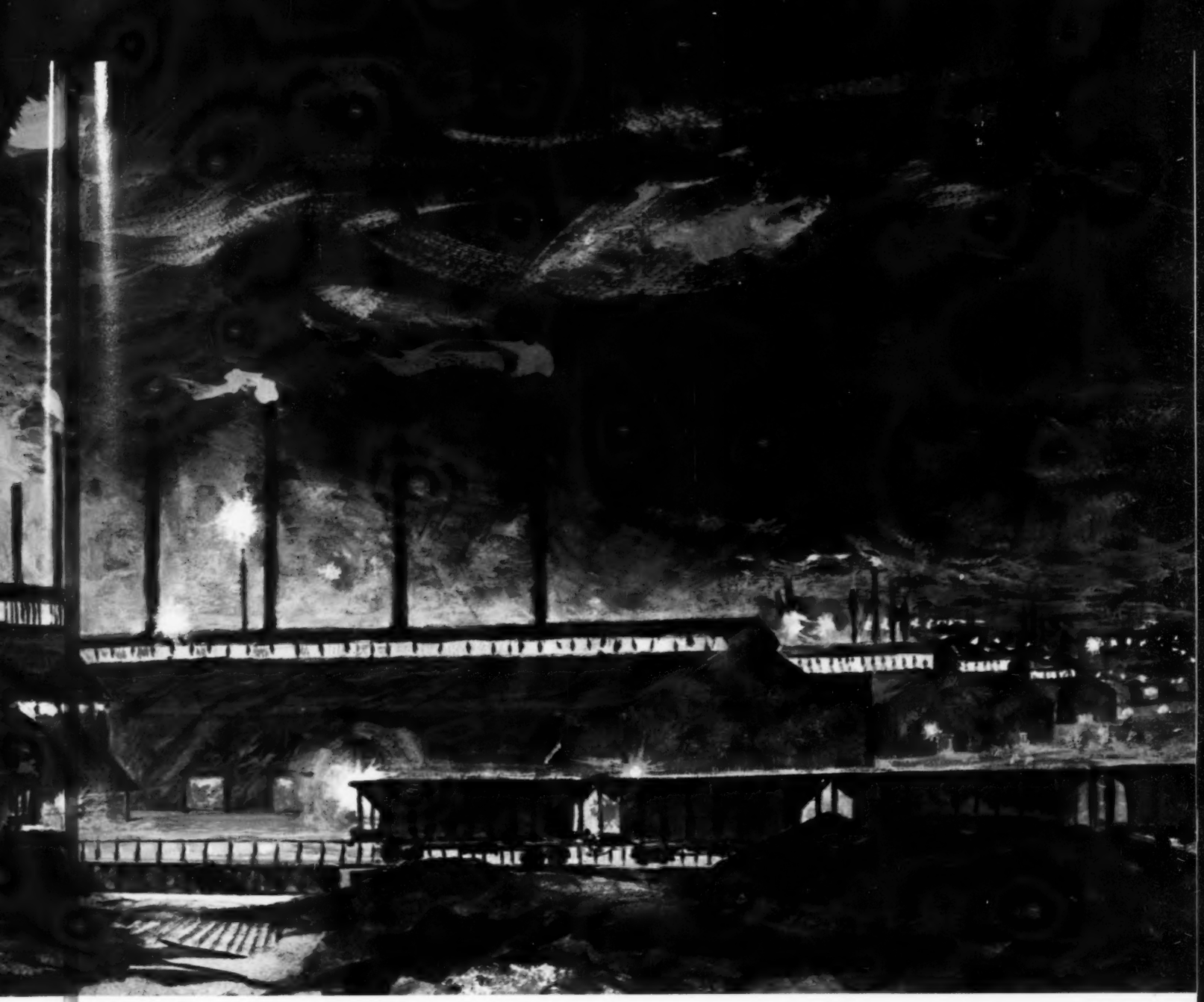
To date, General Electric has concentrated on the complex problems of automating your individual processes. Now, with actual installations completed, individual-process automation has become a reality. General Electric has now taken the next logical step in sound automation planning.

With newly developed products and system technology, General Electric engineers can now link your "islands of automation" to provide complete automation of an entire production area.

With this major phase of your automation program complete, it then becomes possible to link automated production areas by means of a master computer-control system, thus providing completely integrated automation of the entire plant.

Based on a step-by-step modernization approach, General Electric's plan provides flexibility for technological and economic developments in your company. At the same time, it enables you to begin now, taking advantage of the many benefits of automation.

For example, the first step in integrated automation has already been taken by many metal producers. New rolling mills automated by General Electric are automatically keeping strip "on gage" to minimize scrap and boost yield. Primary rolling costs are being reduced through application of G-E programming and



on means effective control of your entire plant

computer systems. G-E automated systems will eliminate charging errors in many blast furnace operations, increasing furnace profits. In many mill operations, G-E automated systems are making available, immediately, critical data in the most usable form to permit wise and timely management decisions resulting in improved and more consistent product quality, reduced operating costs and optimum utilization of the mill.

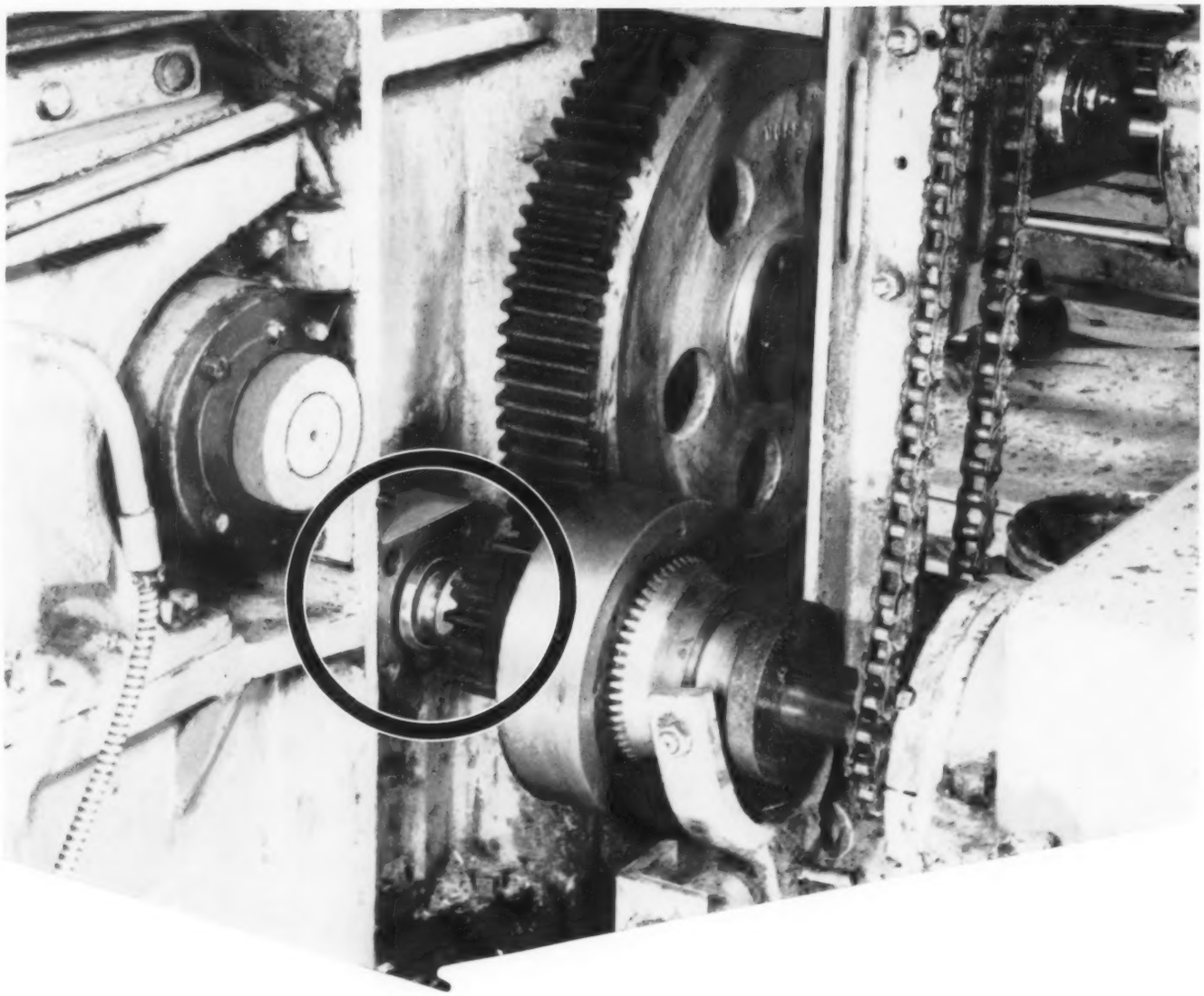
The next step for many of these metal producers will be the linking together of "islands of automation." By application of General Electric automatic computer-control equipment, greatly improved programming for an entire sequence of processes will result. All operations can then be effectively measured and evaluated early enough to allow modifications that will quickly satisfy conditions in any individual process. An entire production area will become responsive to directives originating from a central source.

Finally, as production areas are linked by a master computer-control system, completely automatic production scheduling and manufacturing throughout the entire plant will result. Over-all performance will be in direct accord with management decisions based on incoming orders, related process operations, materials inventories and all of the many complex variables that determine profitable plant operation.

Let General Electric begin working with you now in your planning for future profits. You'll find that the capability to provide the ultimate in automation is a reality at General Electric today. For more details, call your nearest Apparatus Sales Office. General Electric Company, Section 659–131, Schenectady 5, New York.

AUTOMATION THROUGH MODERNIZATION

GENERAL ELECTRIC



Bearings, Inc. engineers will upgrade your equipment - eliminate early bearing failures!

The original bearings on the pinion drive of this corrugating machine had an average life of only three months. Our customer had been advised that only a complete engineering change of machine drive would solve the problem.

Our engineers refused to accept this verdict and after much research found a standard, double row, roller bearing that, plus a standard adaptor, would fill all dimension requirements and give the radial capacity necessary for trouble-free operation.

We solved this bearing problem (as we have solved countless others) because we are authorized distributors for all nationally-known makes of bearings. We know the characteristics of each type of bearing and our recommendations are backed by many years of experience.

When you need bearings for any purpose, call the branch nearest you. We have the most extensive, the most complete stock of bearings and bearing accessories in the world ready to serve you.

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and

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ARKANSAS: Little Rock • **FLORIDA:** Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge New Orleans • **N. CAROLINA:** Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville Memphis • Nashville • **VIRGINIA:** Norfolk • Richmond • Roanoke

Idling at 70° below zero—or pushing at 127°

one NATIONAL brush fits both jobs!

TRADE-MARK

H. H. FRASCH

PROBLEM: This earth-moving equipment operated in rugged terrain where temperatures might vary 200 degrees.

RECOMMENDATION: Henry Frasch and the manufacturer agreed on "National" Brush Grade SA-45.

RESULTS: Excellent cold weather and tropical performance even where commutator speeds reach 5,000 RPM.

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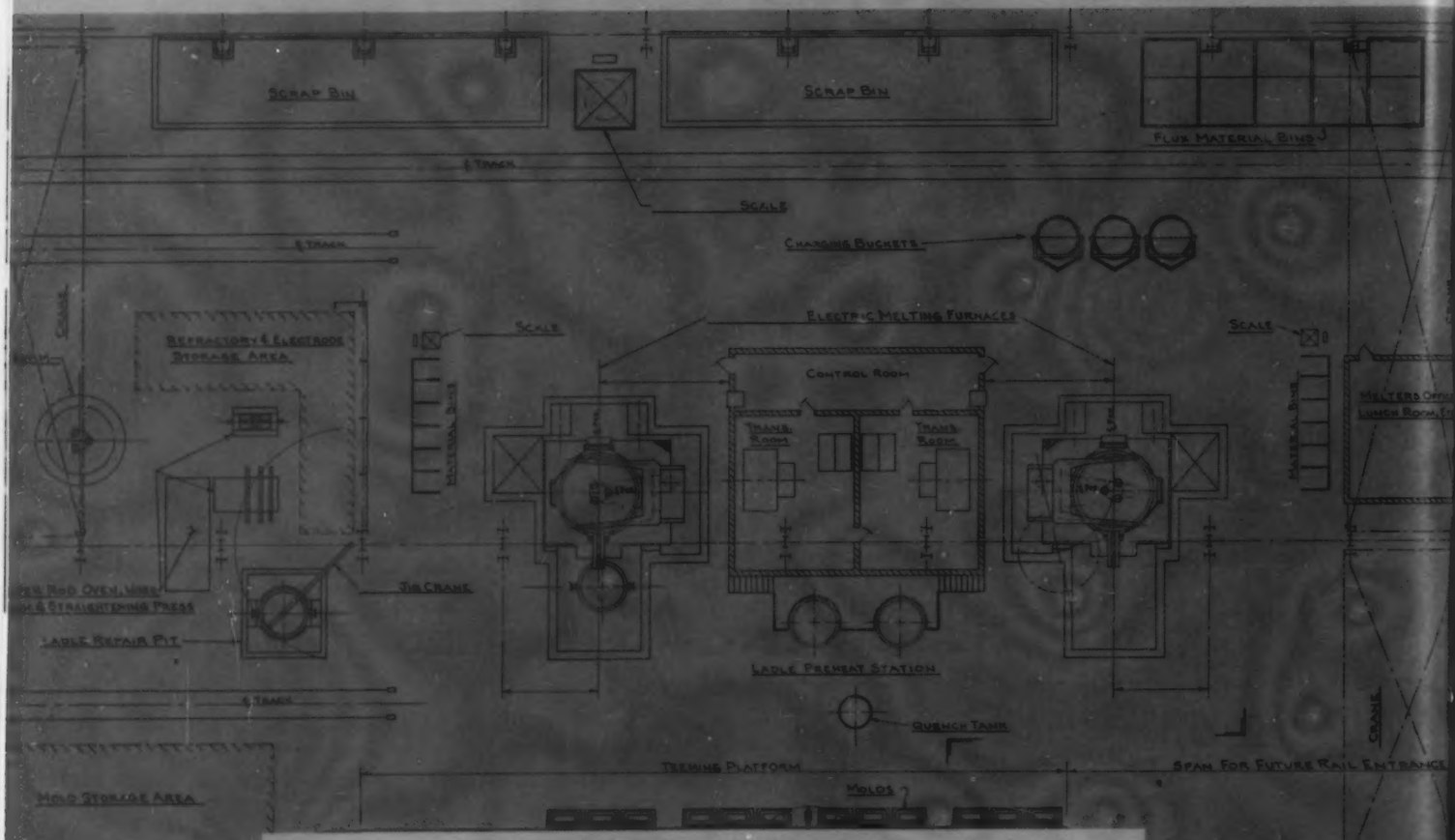
ONE HUNDRED AND TEN YEARS OF

ENGINEERS



Swindell-Dressler engineering for the metals industries is as broad as the widest project requirements—covering every aspect of plant design and construction supervision. From feasibility studies, site evaluation and reports, through electrical and mechanical layouts, trackage, procurement, cost control—any or all factors on the way to completion and owners' key are handled with entire experience and responsibility by this leading engineering organization. Whether your future plans are for a new steel mill, departmental expansion, or remodernization of a melting shop, call us for preliminary discussions that will aid in defining the project. Write, phone or wire.

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SERVICE TO THE METALS INDUSTRY

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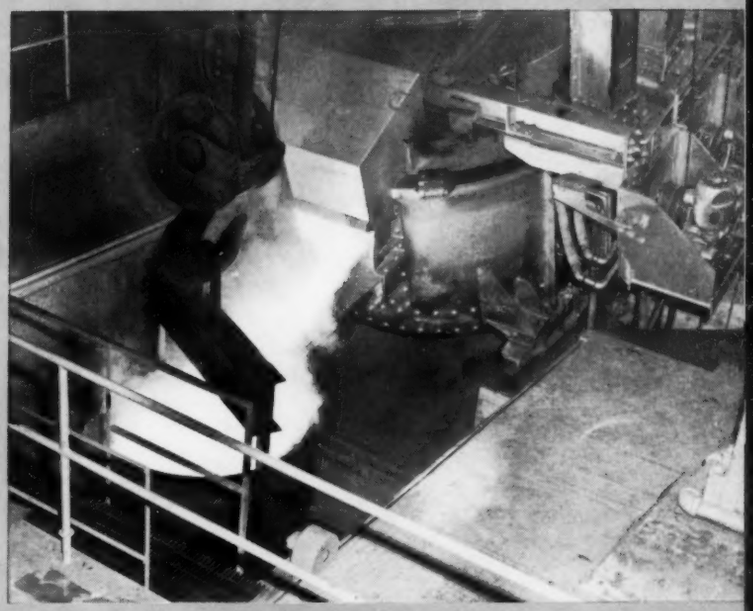

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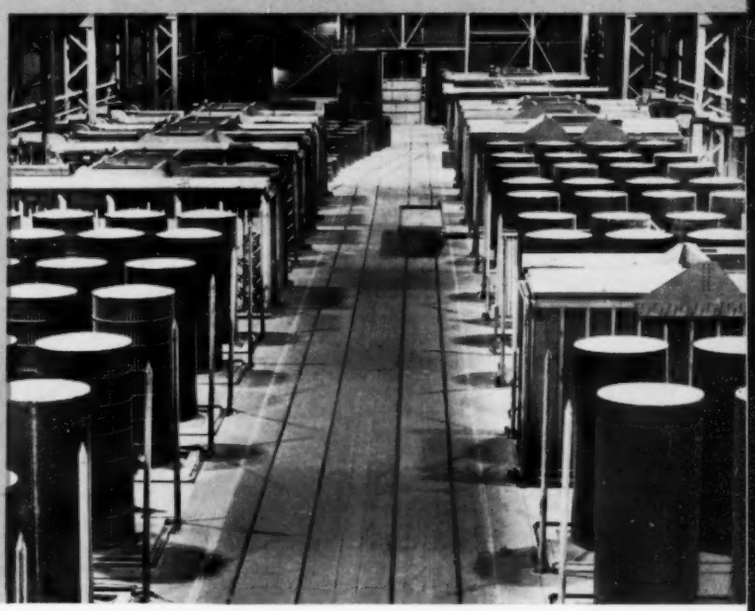
ELECTRIC ARC MELTING FURNACES

Designed and built with the greatest continuity of steel-melting experience in the industry, SWINDELL Electric Arc Melting Furnaces offer the most advanced construction features for increased production rates, lower production costs, and a higher quality product. Let us match your melting requirements with the details of SWINDELL furnace performance, at your convenience.



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ANNEALING FURNACES

SWINDELL Annealing Furnaces in multi- or single-stack units provide complete flexibility in sheet annealing operations, with close control of temperatures. Horizontal radiant tubes and high volume convection system assure correct vertical temperature distribution, better heat application and longer life in service. We will be glad to relate the specific advantage of SWINDELL furnaces to your annealing problems, at any time.

AND ALSO: OPEN HEARTH FURNACES • SOAKING PITS • CAR BOTTOM FURNACES • MALLEABLEIZING FURNACES • HEAT TREATING FURNACES • BILLET HEATING, ROLLER HEARTH and ELEVATOR FURNACES

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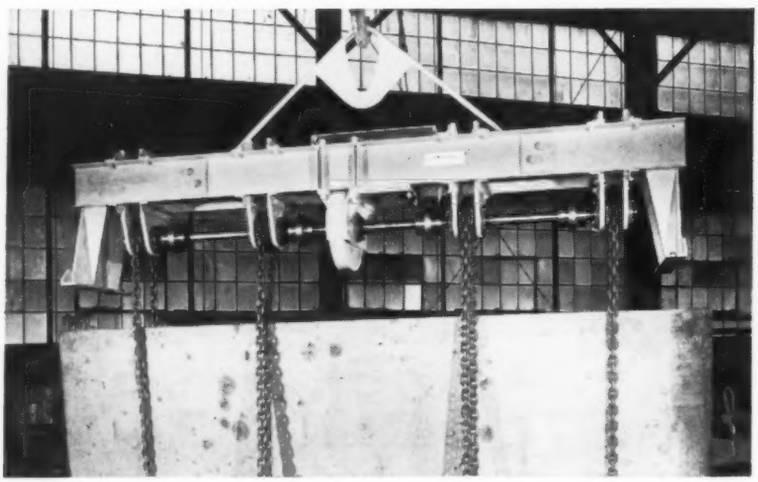
PITTSBURGH 30, PA.

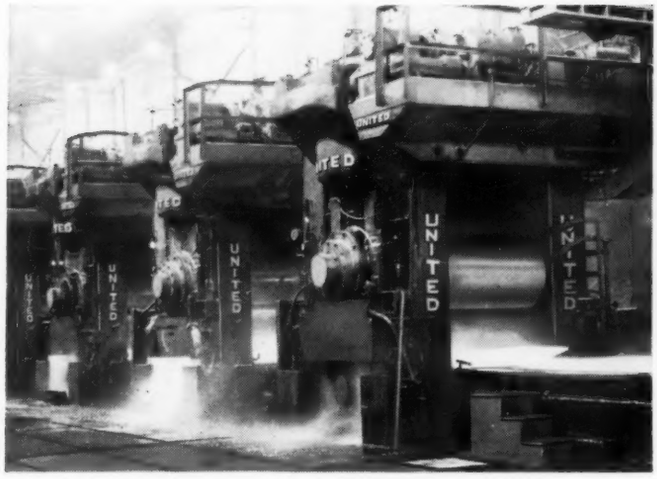
The SWINDELL-DRESSLER CORPORATION of Canada, Ltd., Ottawa, Canada

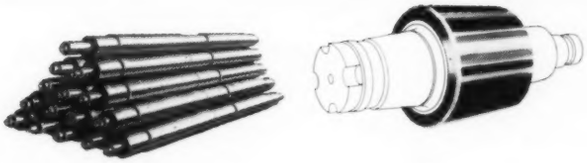
Heppenstall handles it...



Handles it: "If it hangs from a crane, Heppenstall can handle it." Stock tongs are ready for immediate delivery; custom designs are made for special requirements.

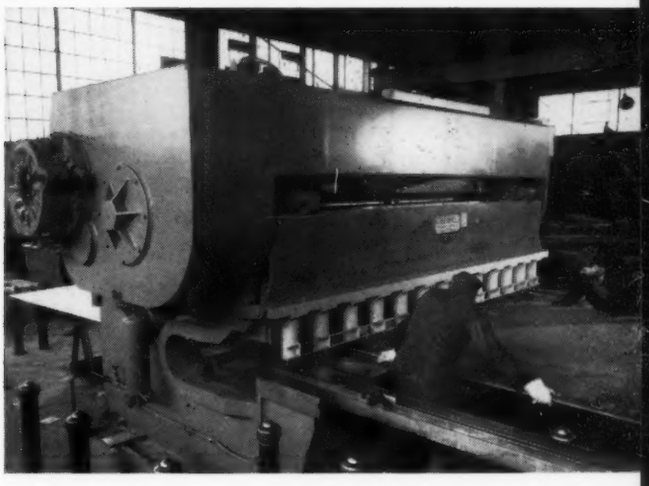
rolls it...





Rolls it: Heppenstall and Midvale-Heppenstall Rolls and Sleeves are made from highest quality alloy steel, thoroughly worked under modern hydraulic presses to obtain maximum density and grain refinement.

cuts it...



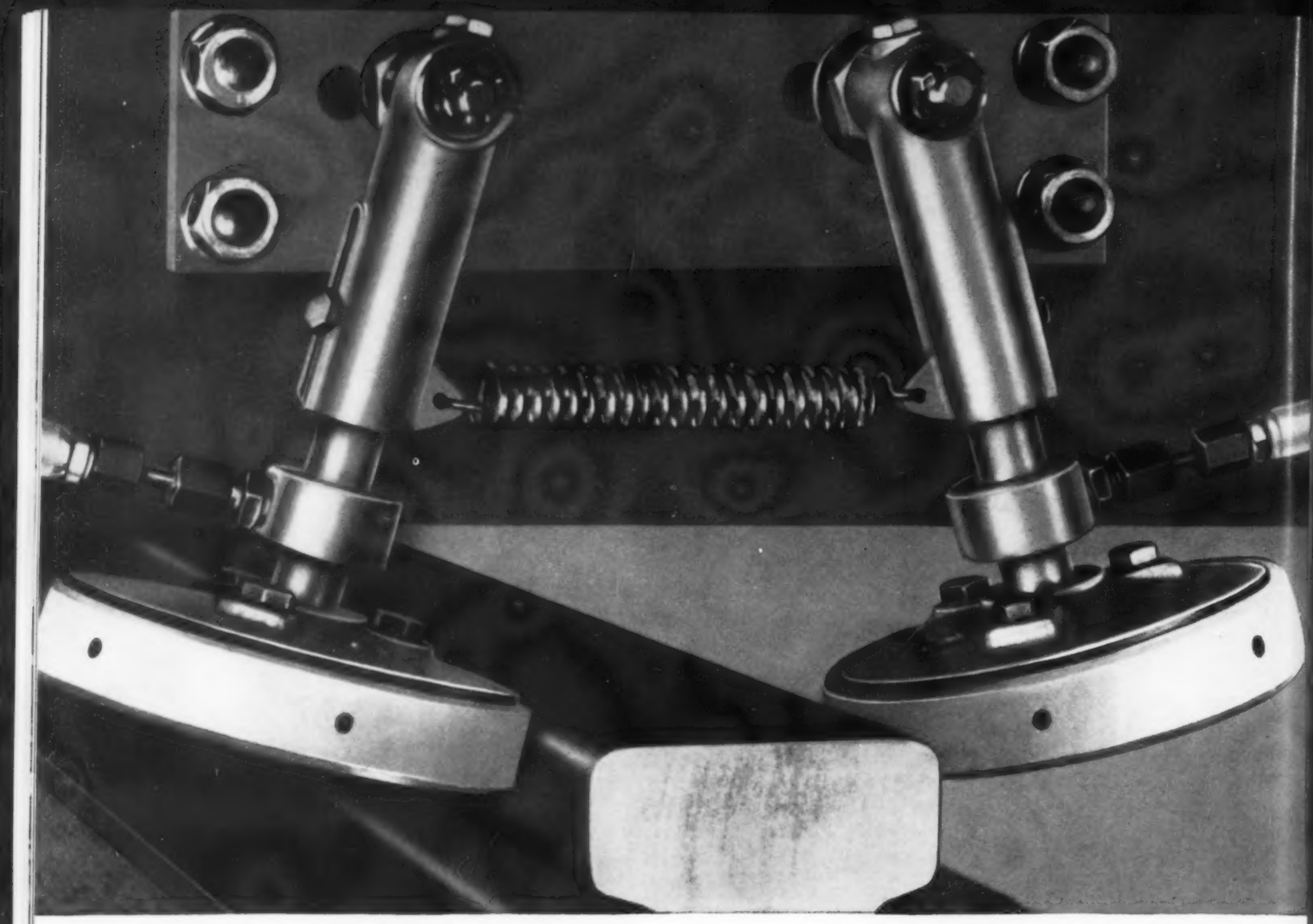
Cuts it: A knife is only as good as the steel that's in it. Heppenstall has the variety of electric steel grades to meet the growing need for knife durability at various shearing speeds.

HEPPENSTALL COMPANY • PITTSBURGH 1, PENNSYLVANIA
Plants: Pittsburgh, Pa. • Bridgeport, Conn. • New Brighton, Pa.

MIDVALE-HEPPENSTALL COMPANY • NICETOWN, PHILADELPHIA 40, PA.

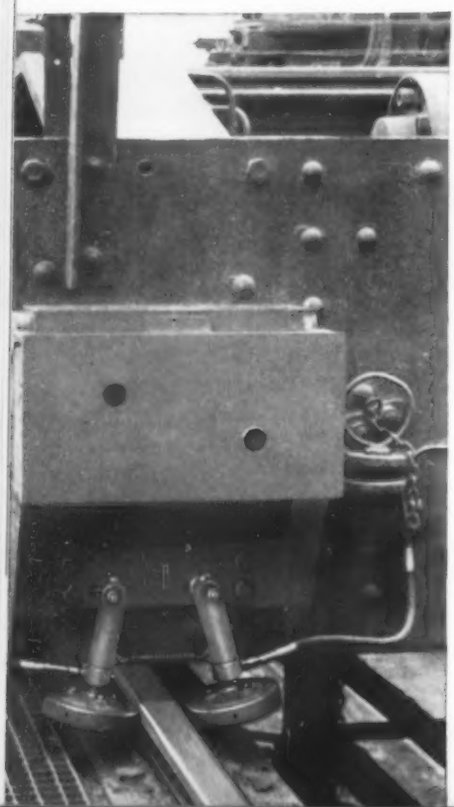
Die Blocks • Forgings • Back-Up Roll Sleeves Rings • Industrial Knives • Materials Handling Equipment • Pressure Vessels • Hardened and Ground Steel Rolls • Vacuum and Consumable Electrode Melted Steels

9236



NEW CRANE RAIL LUBRICATOR

adds 31 months to wheel life on 135-ton crane



Prior to installation of a DeLimon Single Crane Rail Lubrication system, maintenance records on this overhead crane showed down time for wheel change *once every four months.* Today, wheel changes are made only after 35 months continuous service! In addition, the rate of wear on rails has been reduced approximately 20 per cent.

Engineered and built to give positive, trouble-free lubrication, the system operates from a pump actuated by the long travel shaft of the crane. Felt roller pads on applicators mounted on either side of the rail leave a minute film of lubricant as they travel. Available as single and double systems, the lubricator can be used on any size of crane or rail.

WRITE FOR FREE BULLETIN on the new Crane Rail Lubricator. Engineering assistance in centralized lubricating of hydraulic, mechanical, electric motorized and pneumatic equipment also available on request —address: Research Appliance Company, Lubrication Division, P. O. Box 307C, Allison Park, Pa.

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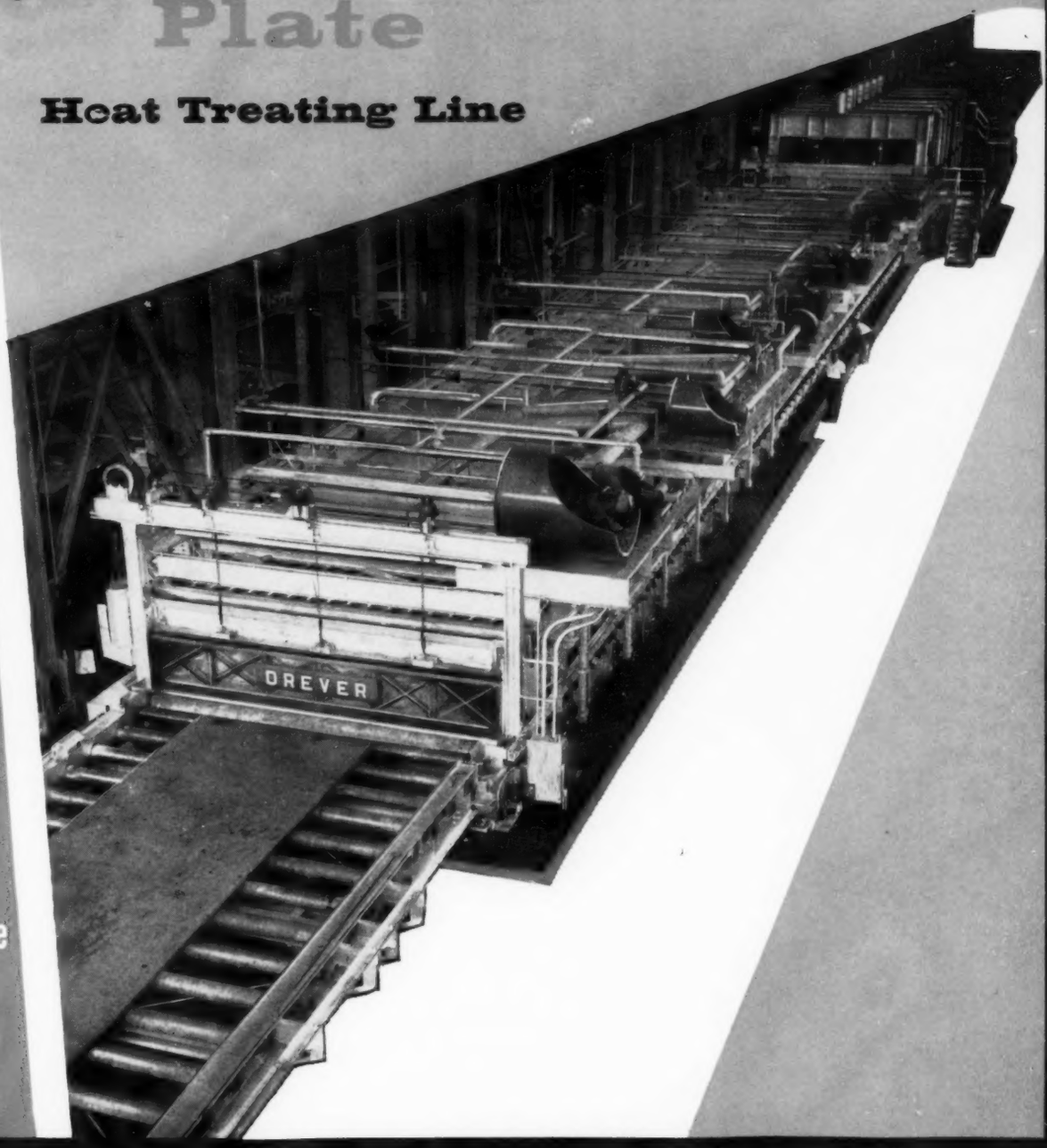
Exclusive Agents for DeLimon in the United States and Canada

DREVER

Plate

Heat Treating Line



Shown is the charging end of a 145′-0″ hardening furnace. In the background can be seen a 2500 ton pressure quench, 200′-0″ draw furnace and the operator's control pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172″ wide x 3″ thick x 600″ long.

The furnace rolls are 25/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.

ENGINEERING AND MANUFACTURING FACILITIES AROUND THE WORLD THROUGH ASSOCIATES IN FRANCE, GREAT BRITAIN, GERMANY, ITALY AND JAPAN

Complete Mill Automation is Simpler,

This blooming mill is equipped with EC&M control, with operator's pulpit located in rear center. When you're planning the automation of *any* mill operation, it makes sense to specify EC&M control. Whether your installation provides programming for cupolas, automatic cranes or ingot buggies, tube or slabbing mills, EC&M has built control systems which are simpler to install and maintain, more economical to use.

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

Less Expensive with EC&M Control

Minimum set-up time saves many man-hours of work. Each EC&M system is thoroughly engineered, tested and adjusted at the factory.

Accuracy and reliability make your production job easier and more profitable. Heavy-duty mill-type components are used throughout. In addition, Square D's new Norpak static control is widely used in EC&M systems for virtually maintenance-free operation.

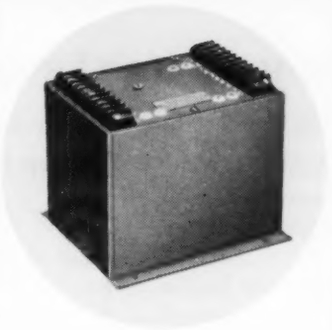
Simple operation means that new operators can be trained quickly. For instance, EC&M automatic screwdown systems are equipped with easy-to-use push button controls, and programming is available by either punched cards or slider panels. Direct reading eliminates coding and de-coding, and there are no schedules to memorize.

Systems for any job are built to fit your exact requirements, including new reactor control for stepless hoist installations. EC&M engineers are trained mill specialists who design, build and install the automatic control system that's best for *your* job.

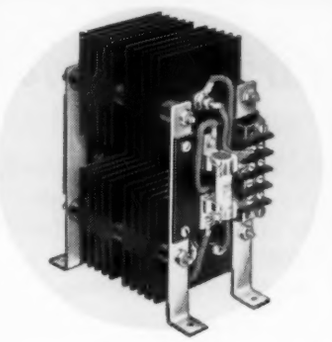
***Write** for detailed information or contact your local Square D field office for details on EC&M automated mill control systems. Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio.*

QUALITY COMPONENTS MAKE EC&M SYSTEMS DEPENDABLE

NORPAK,
Square D's new static control, adds extra reliability to EC&M systems. Transistorized NOR units are compact and sealed in Epoxy to keep out foreign matter and moisture. All external connections are positively made by locked-in tapered pin construction.



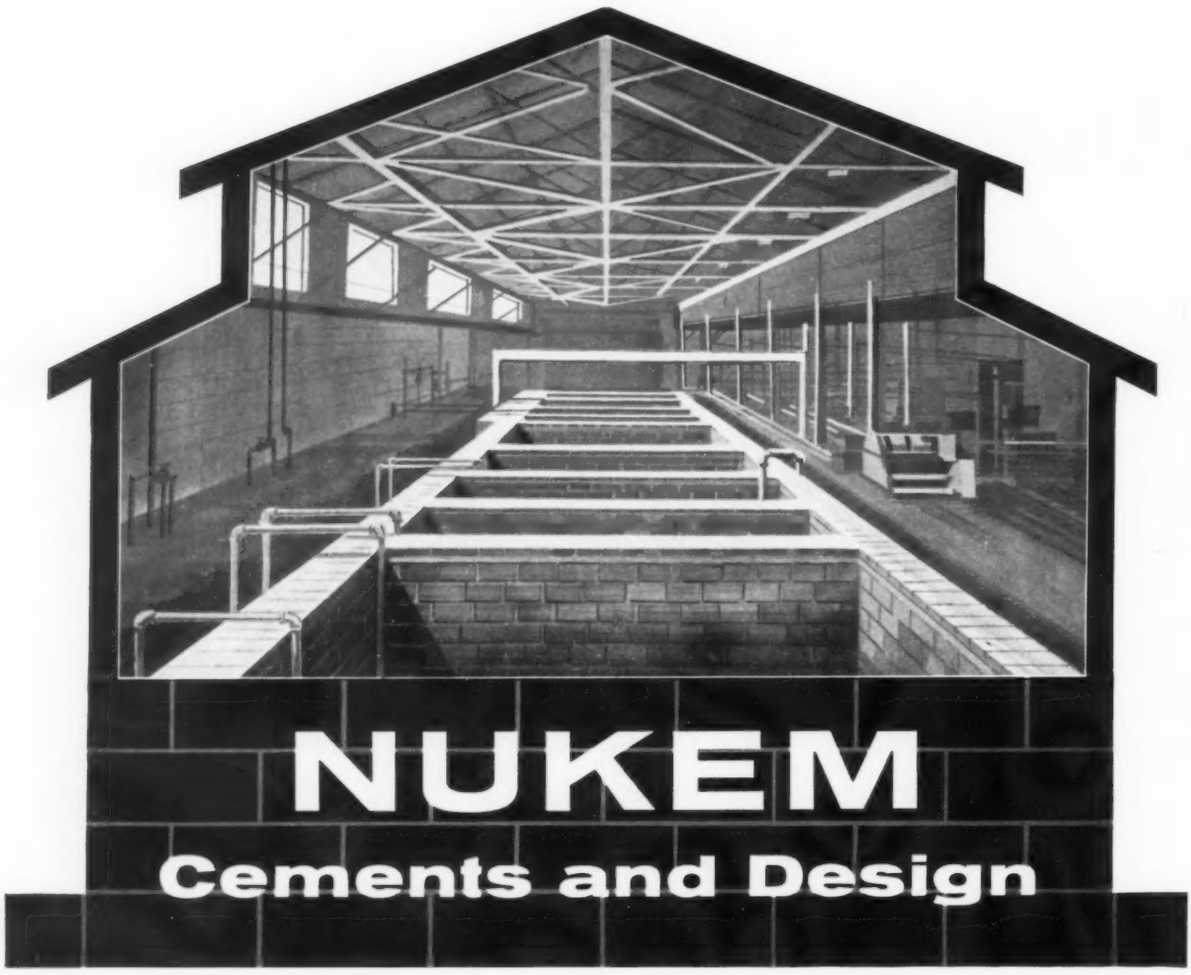
MAGNETIC AMPLIFIER
is frequently used in place of conventional thyratron and rotating amplifiers. Its rugged construction makes maintenance almost nonexistent. Unlike tube-type amplifiers, magnetic amplifiers are not harmed by vibration, will give top performance indefinitely.



SILICON-CONTROLLED RECTIFIER
combines extremely high gain with very fast response. Like the grid in a thyratron tube, a silicon-controlled rectifier passes current only when a signal is applied. As used in EC&M systems, they provide a high-power output directly to a load.

wherever electricity is distributed and controlled

4530



...add years of service to your tanks and foundations

Sulphuric, hydrochloric, nitric or hydrofluoric acids... nickel salts or caustics... no matter what corrosive solutions your processes require, there is a Nukem cement designed for your service.

For over 35 years, Nukem has specialized in the manufacture of a complete line of acid and/or alkali proof cements and linings—each bearing the hallmark of "top quality." Over this same period—employing these products—the name NUKEM has been associated with successful, reliable, corrosion proof construction of Pickling Tanks, Neutralizing Systems, Foundations, Manholes, Trenches and Sewers.

Permanent, satisfactory results depend upon accurate analysis of the problem and selection of the exact material to meet every requirement. Proper design is essential and Nukem engineering "know-how" is at your service. For lasting and economical corrosion resistance, be sure you specify NUKEM.

NUKEM CEMENTS

- NUKEM BASOLIT
- NUKEM SILICATE CEMENT
- NUKEM SUPERTITE
- NUKEM ALL PURPOSE RESINOUS CEMENT
- NUKEM MULTIBOND CEMENT
- NU-KLAD

For information and illustrated technical data write:

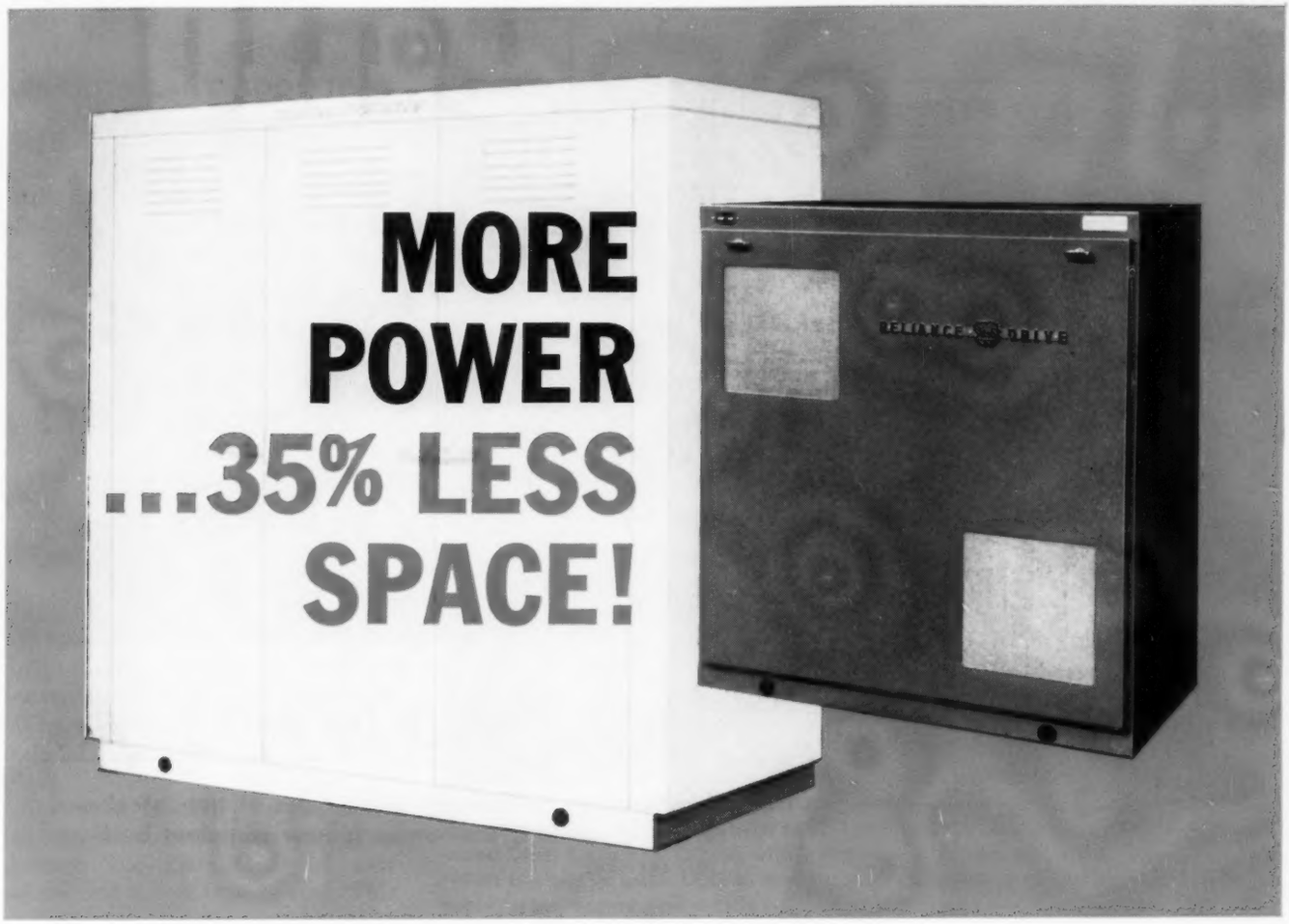
NUKEM PRODUCTS CORP.

Dept. 51 • 4809 Firestone Boulevard • South Gate, Calif.

A Subsidiary of Amercoat Corp.

N 102

Reliance Super 'T' V★S Drives



Both of these control units are rated at 50 horsepower! Actually, the new, small Super 'T' V★S cabinet packs more punch!

LIKE the Reliance Super 'T' Drive Motor, new V★S power units utilize Class B insulation, permitting a more compact unit. 100% overloads of one minute duration are accomplished without failure! Advanced design of ventilation keeps control and power units cooler . . . another reason why smaller size is possible. And service life is substantially extended.

Matched system design of drive motor, power unit and controls produces a highly efficient, integrated drive—to give you a wide range of stepless, variable operating speeds from a-c. circuits.

Super 'T' V★S Drives are available for immediate delivery. Check your Reliance salesman for delivery schedules on the full line, 1—350 hp., Bulletin Number D-2506, has been prepared to give you complete information. Write for it. D-1641

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 119A CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Ohio

FORGED SLEEVES and Cast Steel or Forged Steel Arbors for Back-Up Rolls

A Complete Back-Up Roll Service

Ohio Steel, manufacturers of all types of iron, steel and forged steel rolls, announces a new complete back-up roll service.

Operations Now Include:

- Alloy Cast Steel Back-up Rolls and Arbors
- Forged Steel Back-up Rolls and Arbors from vacuum poured, degassed steel.
- Custom forged Back-up Roll Sleeves from vacuum poured, degassed steel applied to new or used cast steel or forged steel arbors.
- Machine down and resleeve previously sleeved back-up rolls

If you're looking for a complete back-up roll service that'll meet your most exacting specifications, contact your nearest Ohio roll sales engineer.

OR42

OHIO IRON AND STEEL ROLLS

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Flintuff Rolls
- Double-Pour Rolls
- Chilled Iron Rolls
- Nioloy Rolls
- Forged Steel Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls

THE OHIO STEEL FOUNDRY CO., LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO... *Virtually at the center of the steel industry*

Industry News...

SINTER PLANT ADDITIONS ANNOUNCED BY J & L

△ Jones & Laughlin Steel Corp. has installed new-type mechanical dust collectors, and rehabilitated other pollution abatement equipment at the Pittsburgh Works sinter plant.

The new equipment is a part of an expansion project which has increased production by an estimated 200 tons of sinter per day. The unit now has a daily rated capacity of 1850 tons of high quality blast furnace feed. The project also includes a new crusher and screening facilities.

The dust collector, a Dustex Cyclone Collector, has an efficiency rating of more than 95 per cent, which will reduce considerably air pollution from this unit. The collector recovers dust particles by means of a spiral action. Dust then is collected and reused in the sinter plant.

Increased efficiency of the sinter plant has been accomplished through the installation of new pallets and a new type of seal. This replaces the older sliding bar type of seal and prevents leakage and excessive wear, thereby minimizing maintenance on the unit.

PLATE MILL GIRDER HOISTED INTO PLACE

Jockeyed into position with the aid of two giant mobile cranes, this huge double-faced girder will be used to support two 100-ton overhead cranes in Alan Wood Steel Co.'s new 110-in. wide plate mill. It also will allow for columns on 100-ft centers in order that 90-ft-long steel plates can be handled on the transfer table to be located under this portion of the structure. The installation is part of a $36,000,000, two-year modernization now under way at Alan Wood. Due for completion in July, 1961, the program "is completely on schedule," according to William Boger, company vice president of operations.

NEW BRITISH COMPANY ESTABLISHED BY WEAN

△ The Wean Engineering Co. has established a new company in Great Britain to furnish sheet, strip and tin mill equipment of Wean design. Formed in association with John Miles & Partners, Ltd., the jointly-owned company has been named Wean-Miles Ltd.

The new firm will assume the manufacture and sale in Great Britain of many items of equipment designed and sold by the Wean Engineering Co. in the United States and throughout the world. Wean-Miles, will be responsible for the adaptation of British standards to the Wean drawings.

Wean, working through John Miles & Partners, has currently under construction for the British steel industry, one high speed electrolytic tinning line, two continuous strip pickling lines, two high speed shear lines and one high production continuous strip annealing line for tin plate. All of this work is being done in England under the supervision of Wean engineers.

GE ANNOUNCES NEW LABORATORY FACILITY

△ Plans for construction by the General Electric Co. of a $3,000,000 laboratory for the study of advanced manufacturing methods have been announced.

The new laboratory facility will consolidate in one location six manufacturing services components now operating at various locations in Schenectady, N. Y. Construction of the company-wide facility will begin in early 1961 and it is scheduled for completion late the same year.

Scope of the laboratory's activity will be in the areas of research and development, teaching and counseling and dissemination of data on manufacturing methods. The manufacturing laboratory was established by the company in 1952 and since has been responsible for the development of a variety of advanced concepts in manufacturing.

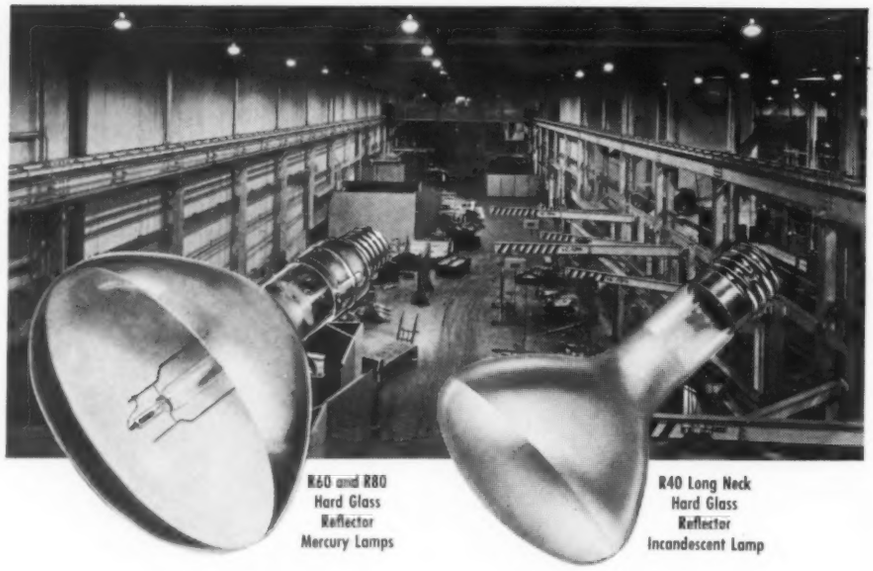
The new structure will contain 170,000 sq ft of floor space. It will house modern offices, laboratory facilities, shops, classrooms and auditorium.

DRAVO CORP. TO BUILD FORD OXYGEN PLANT

△ A new large-capacity oxygen plant, the first of its size in this country designed to produce simultaneously gaseous and liquid oxygen at low pressures, will be built by

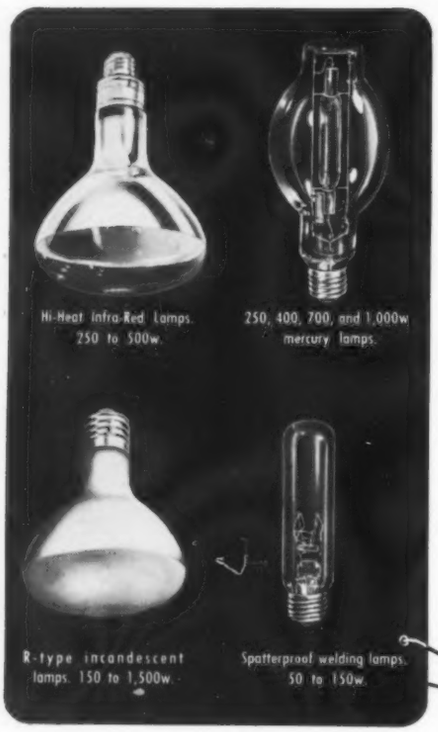
These RADIANT LAMPS

acclaimed by lighting engineers



R60 and R80 Hard Glass Reflector Mercury Lamps

R40 Long Neck Hard Glass Reflector Incandescent Lamp



Hi-Heat Infra-Red Lamps. 250 to 500w.

250, 400, 700, and 1,000w mercury lamps.

R-type incandescent lamps. 150 to 1,500w.

Spatterproof welding lamps. 50 to 150w.

Illuminating engineers have acclaimed Radiant's new reflector lamps as a *great forward step* in lighting factory bays and outdoor areas.

Radiant's new Merco-White lamps offer an exclusive combination of a hard glass bulb, a *built-in reflector plus phosphor coating*. Available in wattages up to 1,000.

The exclusive Radiant long neck, hard glass incandescent reflector lamp eliminates extension sockets.

To meet the growing need of 277 volt electrical systems, the economies of which are recognized by more and more engineers, we can now furnish 300w, 500w, and 1000w incandescent R-type lamps to operate at this high voltage.

Radiant Bulletin 89 gives data and curves, and includes many new lamps, available only from Radiant, that can do a better lighting job for you. Send for it without obligation.

Contract Prices Without a Contract

Send for Bulletin 89

RADIANT LAMP CORPORATION

Industrial Lamp Specialists Since 1938

300 Jelliff Avenue Newark 8, N. J.

Manufacturers of Lamps from 50 to 10,000 watts for PROJECTION • SPOTLIGHT • FLOODLIGHT • INFRA-RED AERONAUTICAL • MOTION PICTURE PRODUCTION • MERCURY VAPOR • GENERAL SERVICE

Visit Booth 57 at the Show

Dravo Corp. for Ford Motor Co.'s Steel Division, Dearborn, Mich.

The new plant, to be owned and operated by Ford, is scheduled to go on stream in December, 1961. It will have a daily production rate of 280 tons of gaseous oxygen, 10 tons of liquid oxygen and 1.4 tons of liquid nitrogen, all three having 99.5 per cent purity.

Gaseous oxygen will be used by Ford in the production of open hearth steels and for general mill applications. Liquid oxygen will be held in reserve standby. When reserve vessels are full, most of the oxygen production can be directed to the gaseous form, thereby increasing the plant's rated capacity for gaseous oxygen. Liquid nitrogen will be used for shrink fitting and cold treatment of metal parts.

The oxygen-generating system to be employed in the Ford facility is the Linde-Fraenkl process, a development of Linde AG of Munich, Germany. Dravo recently acquired distribution rights for the process and equipment from Linde AG.

Principal components of the Linde-Fraenkl plant are a centrifugal air compressor, a centrifugal oxygen compressor and a cold box. The cold box is a metal structure housing heavily insulated air separation vessels.

In producing oxygen by this process, air is pulled through a filter and compressed to 70 psig. Then it is fed to cold box regenerators, which are stainless steel vessels filled with $\frac{1}{2}$-in. quartzite pebbles. Temperature at the bottom of the pebble bed is maintained at -280 F.

Air passing down through the pebbles is cooled. Moisture and carbon dioxide freezes out on the surface of the pebbles. This phase of the process also removes most of the hydrocarbons from the air.

Condensed water is bled off every eight minutes automatically as the flow of gases is reversed in the regenerator. Carbon dioxide and hydrocarbons are purged at the same time. No special equipment for carbon dioxide adsorption or oil removal is required. Freon or ammonia refrigeration is not necessary.

The use of Linde AG expansion turbines permits efficient production of liquid oxygen and liquid nitrogen without any external high pressure refrigeration cycle. Elimination of the need for oil-lubricated compres-

sion equipment, plus the removal of hydrocarbons from incoming air, are two of the principal factors which are responsible for safety records achieved by this type of plant.

Pure oxygen is withdrawn from the cold box at atmospheric pressure. A centrifugal compressor then raises it to 160 psig for use in the steel plant. When gas demand is low the pressure of excess oxygen is raised to 450 psig and it is stored in large surge tanks. Then, on peak demand, the supply is augmented automatically from the surge tanks.

The plant at Ford will consist of a large single story, prefabricated building to house control instruments and compression equipment. The cold box will be constructed adjacent to this building. The large gaseous oxygen surge tanks, a liquid oxygen storage tank and a water cooling tower and pumps will complete the facilities.

BLAW-KNOX AWARDED COLD MILL CONTRACT

△ Blaw-Knox Co. has been awarded a contract for a new six-stand 52-in. cold reduction mill to be installed at U. S. Steel Corp.'s Tennessee Coal & Iron Division tin mill at Fairfield, Ala.

When completed in the early part of 1962, the installation will be U. S. Steel's first six-stand cold reduction mill for tinplate.

It will be capable of cold reducing steel for tinplate at speeds in excess of a mile and a quarter per minute, which is approximately three times the speed of existing facilities which the new mill will replace.

U. S. Steel has announced that the new mill is needed to meet an increasing demand for "thinner and wider" tinplate.

SOUTH WORKS OPERATING GAS TURBINE BLOWER

△ The American steel industry's first gas turbine for blast furnace blowing is in operation at the United States Steel Corp.'s South Works at Chicago.

Made by the Westinghouse Electric Corp. the turbine supplies air required for blast furnace blowing. Blast furnace gas is burned as a fuel for the gas turbine.

This installation requires less

(*Please turn to page 267*)

COWLES
Carbide
SLITTING KNIVES

● Extraordinary results side trimming tinplate, also side trimming and gang slitting light gauges of high and low carbon steel, silicon, tinplate stock, aluminum, brass, copper and other light gauge materials. Permits slitting and side trimming machines to remain in continuous service for long periods without shut-down for re-grinding. Puts all operations associated with slitting and trimming on a practically continuous, uninterrupted basis, cutting costs and increasing output. Solid carbide or carbide rim in steel hub construction. Furnished in a wide range of sizes to meet any side trimming or gang slitting requirement.

Write for New Bulletin No. 601 Today!

Ask us also about
COWLES
Max-Cut; Specialloy; Superalloy; Circle C and Super C Slitting and Side Trimming Knives.
Spacers
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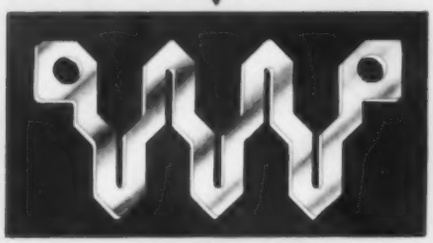
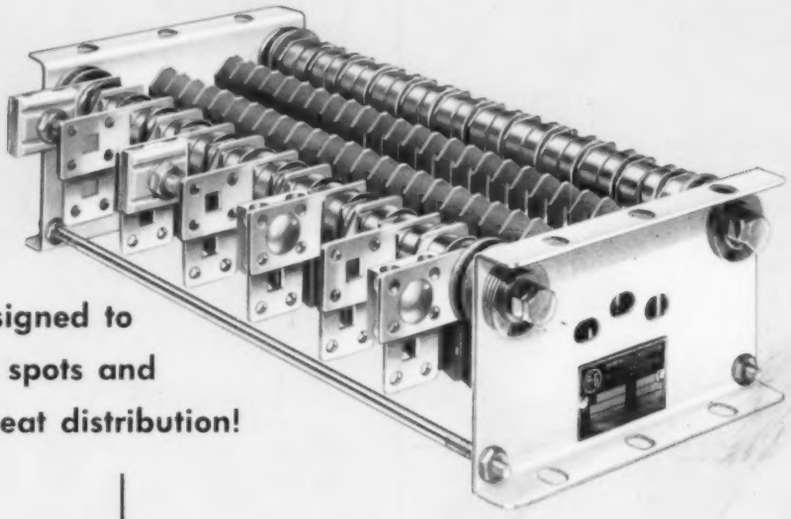
Roll Turning Tools
Carbide Tipped Scrap Chopper Blades
Rotary Cut-off Knives
These tools illustrated and fully described in Catalog No. 561. Write for your copy Today!

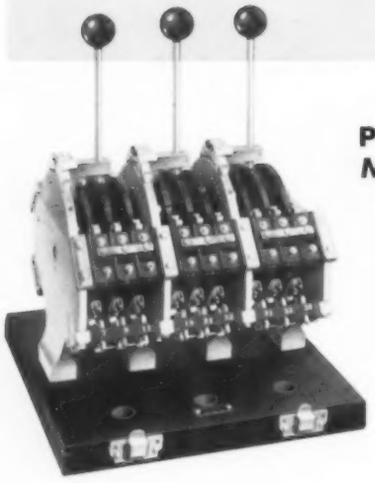
COWLES TOOL COMPANY
2086 WEST 110th STREET • CLEVELAND 2, OHIO

Ventilation *is the HEART of any Resistor...*





P-G GRID . . . designed to eliminate hot spots and insure even heat distribution!



P-G *Improved* **Master Switch**

Lighter in weight
Easier to wire

Type MD for general application in Mill Service

Each single Master has a maximum of 12 circuits and up to 6 points either direction. One to four switches in a single enclosure saves valuable mounting space. Overall length less than 22" on four unit switch. Short lever travel. Self-lubricating bearings. Fine silver double break contacts. Spring return (optional). Enclosure easily removed.

Write for Bulletin No. 410

Longer resistor life depends on adequate ventilation and how efficiently heat is dissipated. P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat thruout the grid area . . . note illustration.

Compare P-G with any other punched steel grid resistor — you will find more air space is provided. This produces better ventilation — longer resistor life and over twenty-five years of use in steel mill service has proven this.

For the maximum in resistor value, try P-G the ORIGINAL Steel Grid Resistor.

Write for Bulletin No. 500

P-G PRODUCTS ON DISPLAY, IRON AND STEEL SHOW... **Booth 81**

Established 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—**Kenton Lands Road, Erlanger, Kentucky**

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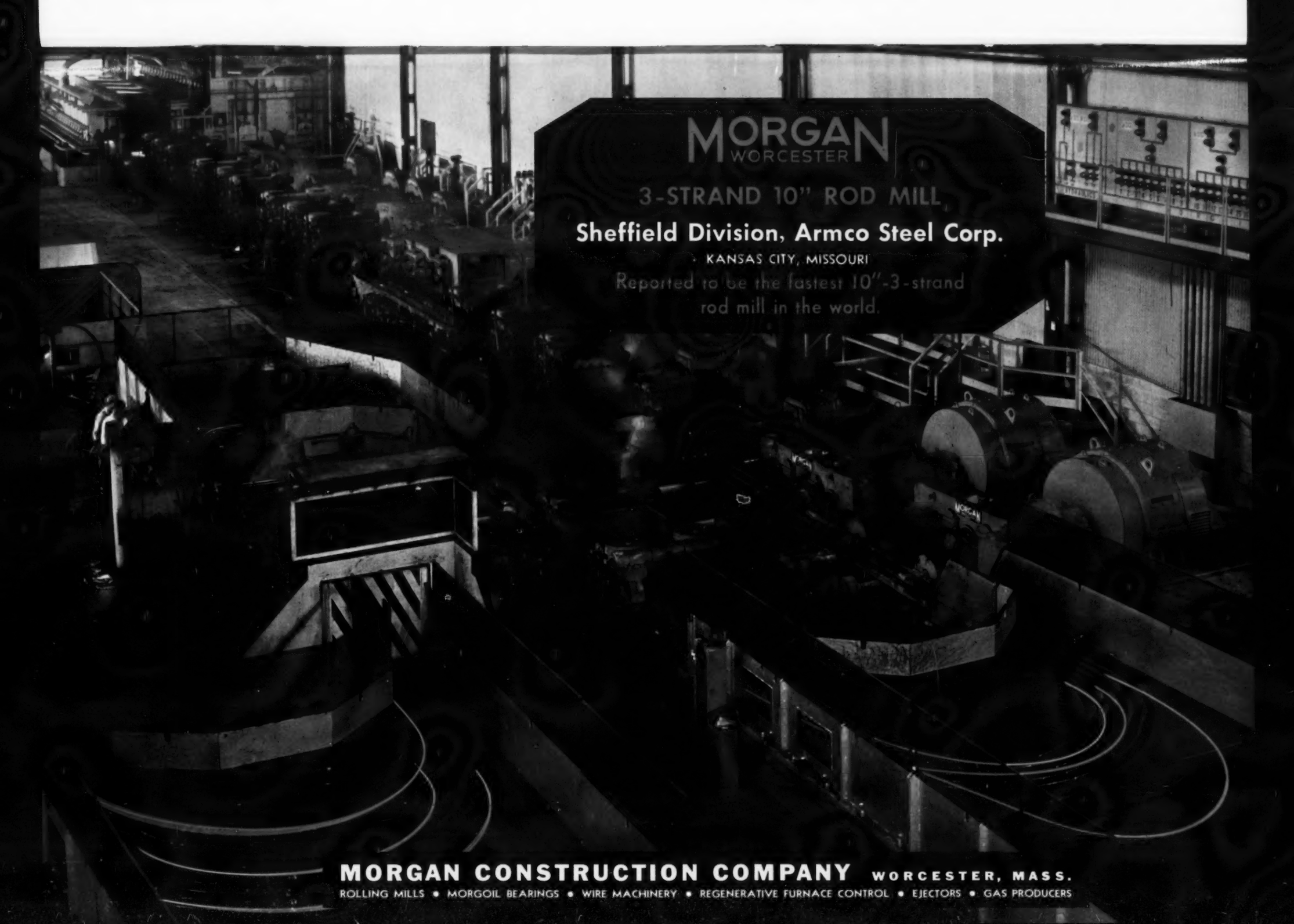


MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • WIRE MACHINERY • REGENERATIVE FURNACE CONTROL • EJECTORS • GAS PRODUCERS

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

Semi-gantry crane handling billets with EUCLID MAN-NETIC Control.

EUCLID Steel Mill Control

Complete D-C Speed Controllers

Packaged Man-Netic Controllers, with negative line contactor, are compact, provide full magnetic control and positive cam opening of power contacts. Available in either reverse-plugging or dynamic-lowering types for all heavy-duty applications.

Please contact your nearest EUCLID Representative

WHAT'S YOUR PROBLEM?

Ask for Bulletin 4400

The EUCLID Electric & Mfg. Co.

Dept. A • MADISON • OHIO

(*Continued from page 263*)

space than a conventional steam turbine driven blast furnace blower and boiler, and it uses practically no water.

The axial compressor of the gas turbine supplies 125,000 cu ft of air per minute to the blast furnaces, in addition to the air which is used in the combustion system of the turbine itself.

WESTINGHOUSE SUPPLIES BRAZILIAN STEEL MILL

△ A $22,000,000 contract covering electrical drives, motors and controls for one of Latin America's largest industrial projects, an integrated steel mill in Brazil, was announced by the Westinghouse Electric International Co.

Companhia Siderurgica Paulista (COSIPA) is building the mill which will have an initial annual capacity of 1962 of 600,000 tons of sheets and plates. The mill, in Piacaguera, in the state of Sao Paulo, is scheduled for full production in 1967 when its capacity will be 2,500,000 tons of finished products. The mill will employ about 10,000 persons.

Westinghouse electrical equipment has been specified for six rolling mills, three process lines and a blast furnace. Ratings of the main drive motors will total 50,600 hp; motor-generator sets and rectifiers, 40,000 kw.

COSIPA is installing six rolling mills, a 44-in. slabbing mill, a 110-in. reversing plate mill, a 66-in. continuous hot strip finishing mill, a 66-in. three-stand tandem cold mill, a 66-in. four-high temper mill and a 66-in. two-high skin pass mill. The three process lines are a 60-in. heavy gage upcut shear line for hot rolled sheet, a 60-in. cold rolled shearing line and a continuous pickle line.

The control system Westinghouse is supplying for the mill will feature the latest static and magnetic amplifier developments. All constant voltage d-c electric power equipment will be supplied by Westinghouse silicon rectifier substations.

AWARD MILL CONTRACTS TO D. W. MURRAY CO.

△ Contracts in excess of $5,000,000 for steel plant expansion have been awarded to the David W. Murray Co. Work will be started immediately at the Mid-West Steel Corp. on a project involving complete mechanical erection, piping and electrical installation of a new electrolytic tinning line and a new galvanizing and annealing line.

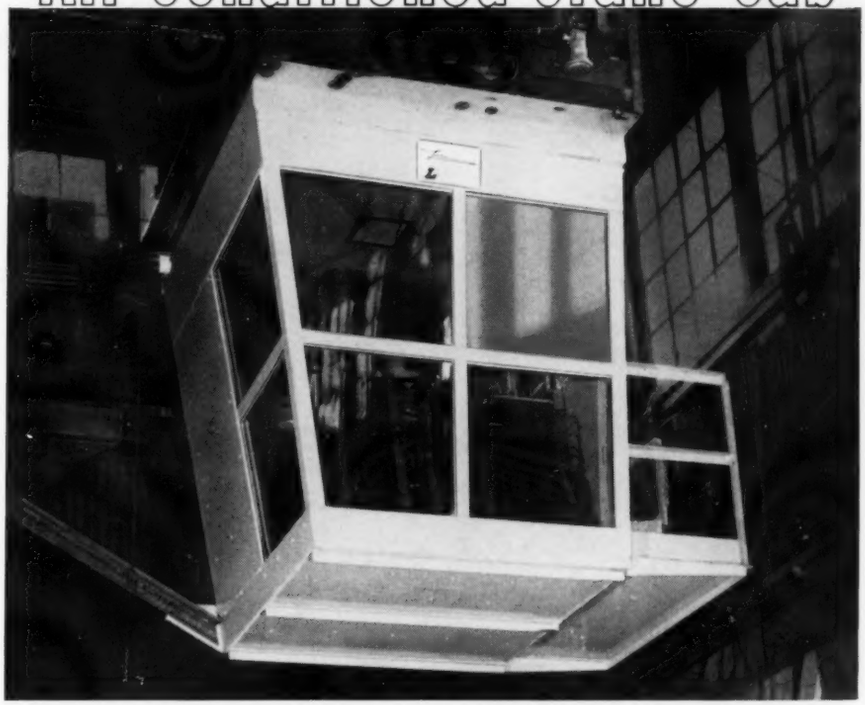
TO BUILD INFRARED ORE CAR THAWING FACILITY

△ A contract for fabricating electric infrared ore car thawing installations has been awarded to Radcor, Inc., subsidiary of Edwin L. Wiegand Co., by the Chicago and North Western Railway Co.

The installation will be made in the railway company's new ore car thawing facility to be built near its ore dock at Escanaba, Mich.

The 276-ft metal building, scheduled to be finished by the end of 1960, at a cost of more than $250,000 will be one of the largest of its kind designed for electrically thawing iron ore moving at below freezing temperatures. It will be utilized for

Air Conditioned Crane Cab



..Built..Air Conditioned and guaranteed by Lintern

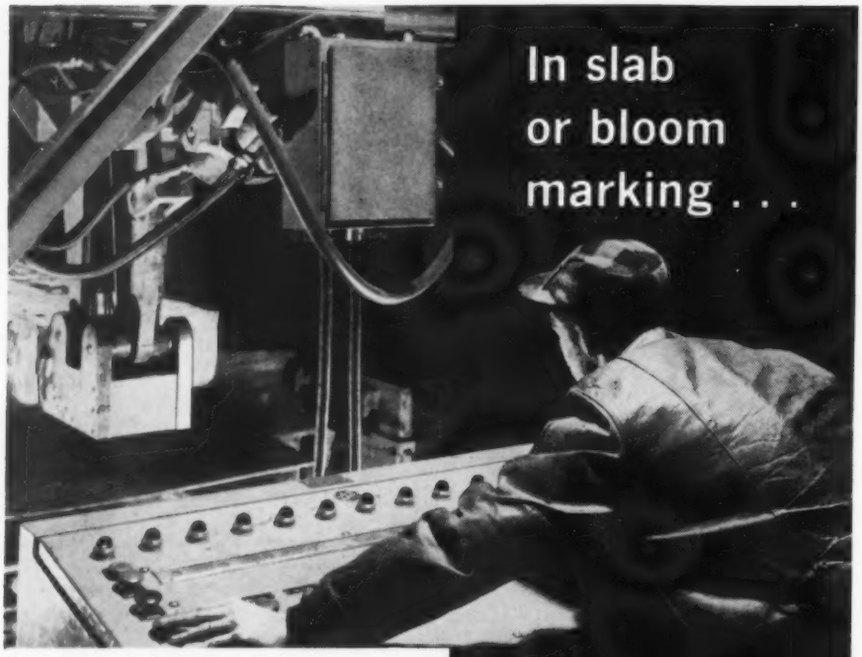
Lintern air conditions existing cabs and also builds solid, well insulated replacement cabs to your requirements.

This new Lintern cab complete with air conditioning is shown as it was being installed at National Tube Division of United States Steel, Lorain, Ohio. In the same plant Lintern crane cab heaters as well as air conditioning equipment have been installed on new cranes.

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

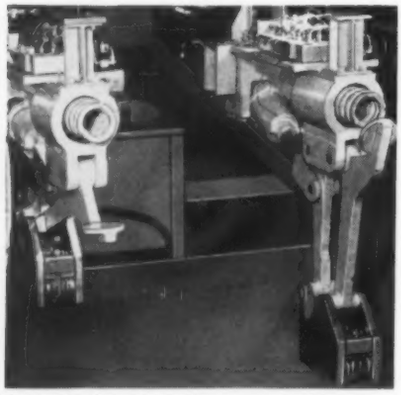
Booth 61

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

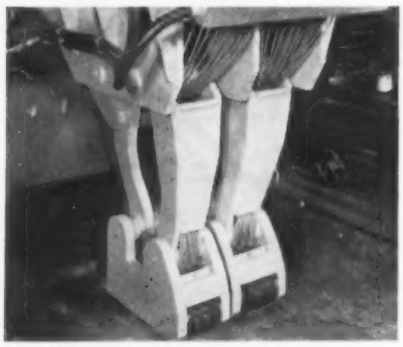


In slab or bloom marking . . .

Operator presses button to actuate stamping cycle or change characters—installed at a transfer table.



Twin units for automatic consecutive numbering of 2½" bar billets—for installation along edge of cooling bed.



Double-headed Slab Marker with 18 stamping wheels, photographed during testing—for installation over a roller line.

CUNNINGHAM HAS THE EXPERIENCE

14 UNITS IN SERVICE . . . MORE ON ORDER

Under constant development for more than 12 years, Mecco Safety Slab Markers are the industry's most advanced—*the most thoroughly service-proved*, by a margin of hundreds of thousands of tons.

We'll gladly consult with you on any phase of steel industry marking. *May we send technical bulletins on Slab Markers?*

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

Mecco SAFETY MARKING TOOLS

M. E. CUNNINGHAM CO.
1041 CHATEAU STREET
PITTSBURGH 33, PENNA.

ore moving to Escanaba over the only dock on Lake Michigan for transfer to ore boats destined for steel mills in the Chicago and Lake Erie areas.

This method of thawing ore by means of electric infrared will replace the conventional steam thawing facilities. It will result in more efficient and much faster means of moving frozen ore to market and will allow extension of the ore shipping season until ice on the lakes halts water transportation.

The infrared electric heating elements will have an input of 5000 kw and be installed in long banks at the bottom, sides and top of the tunnel-like structure. Iron ore in railroad cars moving into the building will absorb the heat radiated from the heating elements. The facility will accommodate 10 seventy-ton ore cars at a time for rapid thawing.

WHEELING REBUILDING PROJECT UNDERWAY

△ Wheeling Steel Corp.'s No. 3 battery of 51 coke ovens at the Steubenville Works has been taken out of service for a $4,500,000 rebuilding project. H. Nelson Lang, general manager of the Steubenville plant, said that the project will require 12 months to complete.

The coke ovens as rebuilt will be of the same type as the No. 2 battery of ovens installed at the Steubenville Works in 1954.

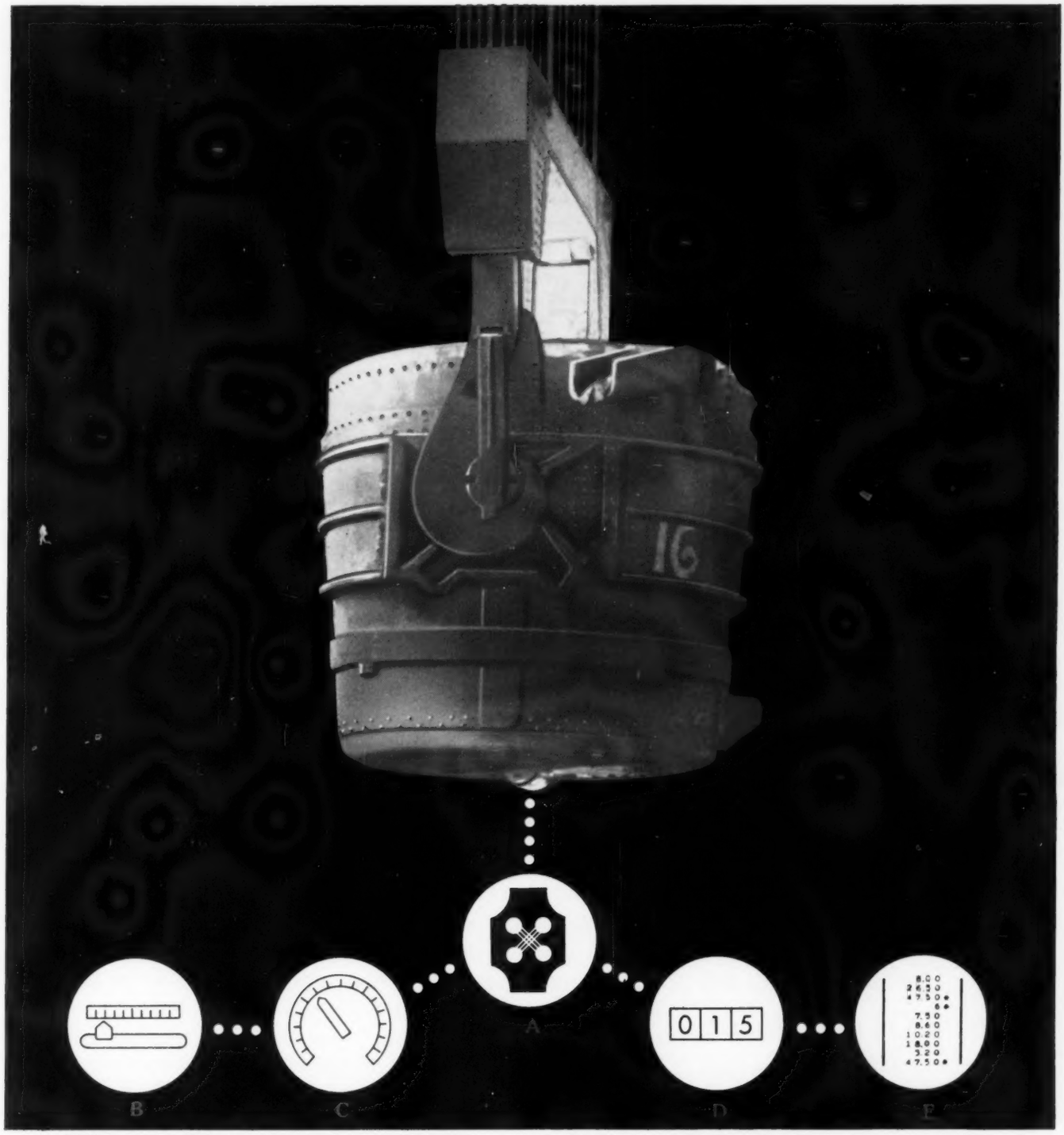
The No. 1 blast furnace at Steubenville has also been taken out of service for a major rebuild and capacity increase project, involving an expenditure of more than $3,000,000. New equipment to be installed includes a turboblower with a blowing capacity of 110,000 cu ft per min.

Mr. Lang said that the furnace has produced more than 2,250,000 tons of pig iron since it was last relined in 1952.

The project is expected to require about six months to complete. The No. 1 furnace is one of five blast furnaces at the Steubenville Works.

ANNOUNCES COMPLETION OF TWO MILL ORDERS

△ Mesta Machine Co. has completed manufacture and shipment of the world's first six stand four-high tandem cold reduction mill for the



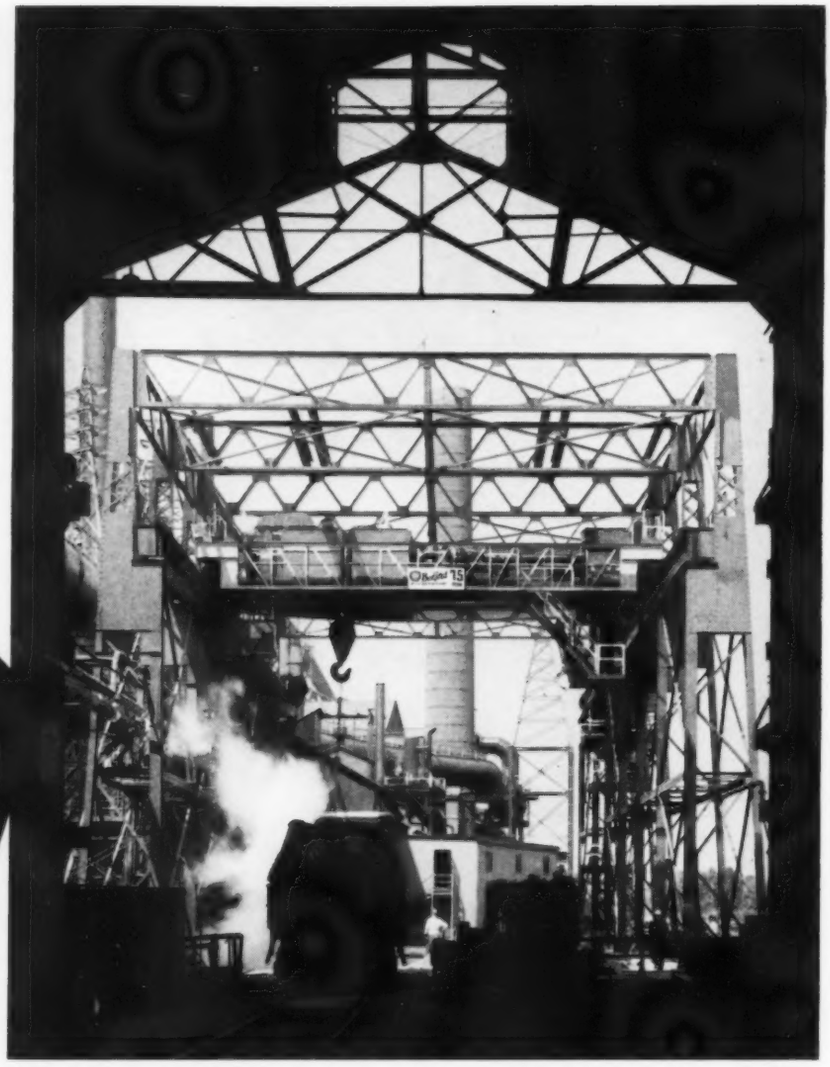
Weigh Molten Steel In Transit With ASEA's Pressductor

Save one big step with this new application of Asea's Pressductor. The Pressductor measures the accurate weight of molten steel or other crane suspended loads in transit. Gone is the non-productive, tedious–and frequently inaccurate—weighing stage. Here is how it works: mounted on the crane (and it can be easily installed), the Pressductor **A** senses the load, gives rise to a changing magnetic flux. This induces a voltage which is then read on a pointer–indicating instrument **C** a digital voltmeter **D** paper tape or a punched card recording unit **E**. The Pressductor can be connected to a device giving a signal when crane is overloaded **B**. The indicator can be placed in the operator's cabin or mounted on the crane, so that it can be seen from the ground. This is the very same compact Pressductor which is used in most rolling and strip mills to measure and register heavy roll pressures. It allows uninterrupted production, gives you accurate weighing, can supply a permanent record of every stage of your operation with a minimum of attention and maintenance. It does not involve any major change in your crane—and Asea will supervise the installation. For further information, full details, specifications, write to: ASEA ELECTRIC, INC., 500 Fifth Avenue, New York 36, N. Y., 55 New Montgomery Street, San Francisco, Calif.

ASEA

IN STEEL MILLS

WEIGHT LIFTING MADE EASY



Yuba designs and builds all types of custom steel cranes with lifting capacities of 5 to 1000 tons, for indoor or outdoor service.

Yuba-Bedford Steel Mill Cranes are working to plant capacity —24 hours a day —year after year

Two generations of steel makers have operated Bedford Cranes in mills from Pennsylvania to Peru. These are mills where the handling jobs are tough—where cranes work shift after shift under all conditions —and where there's time for only routine maintenance.

Hundreds of Bedford Cranes have been manufactured for leading steel producers...cranes that are specially designed and custom-built by Yuba to the tough requirements of the steel industry. Big lifting problems are made easy on every shift—for years!

Yuba designs, builds and erects all types of cranes including bridge, unloading and material handling, gantry and semi-gantry, floating and jib cranes. Also derricks, hoists and launching towers for defense ordnance.

specialists in steel mill cranes and custom cranes of all types

YUBA-BEDFORD CORP.

1108 Fifth Street, Bedford, Indiana · A subsidiary of

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

Indiana Harbor Works of The Youngstown Sheet and Tube Co. This new 52-in. mill represents a major equipment innovation in the high-speed production of light gage tinplate by rolling strip steel at speeds up to 7250 fpm.

When installation is completed, the mill will cold roll steel strip in widths up to 46 in. and deliver coils 80 in. in diameter, weighing over 62,000 lb. The 34,900 hp provided for the main drives is the largest known application of power for a cold reduction mill.

Mesta has also completed manufacture and shipment of an automatically controlled reversing plate mill with two vertical edgers and auxiliary equipment for Republic Steel Corp. at Gadsden, Ala.

When installation is complete, this mill will roll reheated slabs into plate up to 126 in. wide and also operate as a reversing rougher to do the preliminary rolling of steel slabs for the hot strip mill.

Completely automatic operation of this installation will be controlled by a card-programmed system to reduce slabs for rolling in the hot strip mill finishing stands. This system will control the speed and roll opening of the two vertical edgers and the plate mill, the reversing of mill tables and rolls, sideguard adjustments, and descaling sprays. When the mill is scheduled to roll skelp of wide widths, the slab is rolled broadside. The tapered rollers for turning the slab are manually operated, but all other operations are automatically controlled.

RESERVE BEGINS WORK ON EXPANSION PROGRAM

△ Construction work has begun on Reserve Mining Co.'s program to expand its taconite processing facilities by approximately 50 per cent.

Major elements of the expansion include:

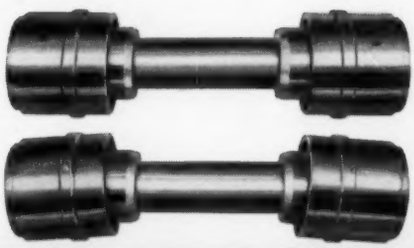
(1) Increasing iron ore pellet producing capacity to more than 9,000,000 long tons annually. Present capacity is about 5,500,000 tons.

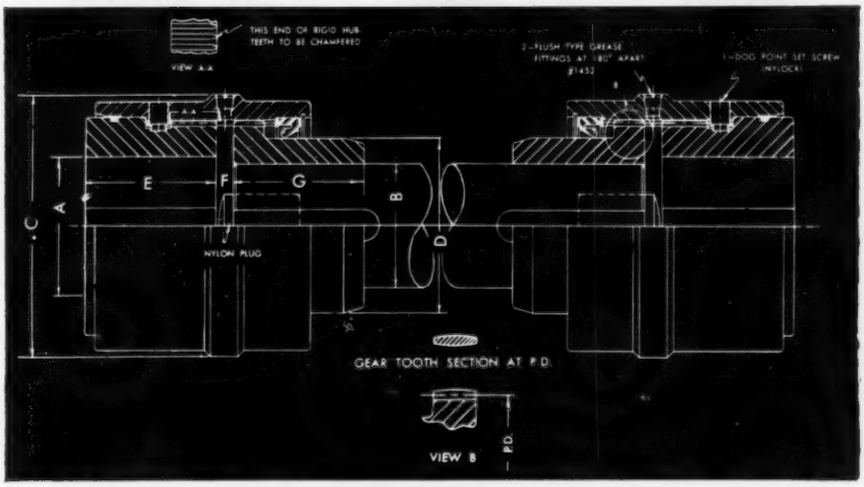
(2) Construction of a second coarse crushing plant near the company's mine at Babbitt, Minn.

(3) Building a second rail line along the present 47-mile railroad used to transport the crude rock mined at Babbitt to the processing plant at Silver Bay.

design facts....on

WALDRON High Misalignment Series "X"





COUPLING SIZE	H.P. PER 100 R.P.M.	MAX. BORE RIGID HUB A	MAX. BORE GEAR HUB B	C	D	E	F	G
1¼X	3½	1⅜	1¼	3¾	2	2⅛	¼	2
2X	12	2⅛	2	4 17/32	2⅞	2⅜	5/16	2¼
2½X	26	2¾	2½	5 5/16	3⅝	2¾	⅜	2¾
3X	50	3⅜	3	6 1 1/32	4¼	3¼	7/16	3¼
3½X	86	4	3½	7⅜	5	3¾	7/16	3¾
4X	130	4½	4	8 7/32	5¾	4¼	½	4¼
4½X	210	5¼	4½	9 7/16	6½	4¾	½	4¾

The Series X coupling is specifically designed for transmission of power in applications where shaft misalignment is too great to be handled by a standard gear coupling.

Each coupling assembly has two rigid hubs, mounted on drive shaft and driven shaft, each connected to a one piece sleeve by a spline used for driving purposes only. This spline extends only a portion of the hub length, and the remaining length of the hub is a turned surface which fits snugly into the counterbore in the sleeve to provide a suitable bearing surface. These two sleeves are connected by a floating shaft on both ends of which are mounted flexible hubs with gear teeth of unique design which permits misalignment up to 5°.

Series X couplings are easy to dismantle and reassemble. By backing off the set screws, the sleeves can be disengaged from the rigid and flexible hubs. Specially designed seals and steel protecting rings are held in place in the sleeves with Spirolox rings. End portions of the gear hubs are tapered for easy reentry of the seal in reassembly.

All load carrying parts are machined from high strength alloy steel. Floating shafts to customer specifications have nylon plugs inserted in each end to limit axial float and to prevent damage to the lathe centers of the roll shafts.

Write for Catalog

WALDRON Couplings

WALDRON-HARTIG DIVISION
MIDLAND-ROSS CORPORATION
BOX 791, NEW BRUNSWICK, N. J.
SALES REPRESENTATIVES FROM COAST TO COAST

"See Us At Booth 94 At The Iron & Steel Exposition"

Proved by Years of Hard Service on Mills and Heavy Duty Machines Throughout Your Industry

Ajax Dihedral Spindle Couplings have been helping builders and users of new and modernized ferrous and non-ferrous mills achieve new standards of performance, quality, high production and maintenance economies.

They are operating on every type of mill and heavy duty machines including bar, rod, hot and cold strip, stretch reducing, tube straightening, temper, skin pass, shears, etc.

Ajax patented Dihedral Tooth Design, perfected lubricant seals and other features have contributed to new output records, better surface finish and closer gauge tolerance of new and modernized mills throughout the world.

Take advantage of AJAX factory trained and on-the-job field experience of Ajax Sales Representatives to give you personal liasion with the Ajax Engineering Department.

Ask for Latest Ajax SELECTION GUIDE
Just off the Presses

See Why and How at the Cleveland Exposition, Booth 101-3

AJAX FLEXIBLE COUPLING CO. INC.

20 PORTAGE ROAD • Incorporated 1920 • WESTFIELD, N. Y.

In Canada—The Alexander Fleck Ltd., Ottawa, Ont.

(4) Installation of a second car dumper at Silver Bay.

(5) Expansion of the fine crushing, concentrating and pelletizing plants located on the shore of Lake Superior. The largest of these buildings is presently 1350 ft long and will be lengthened to 2150 ft, to house additional complete production lines.

(6) Doubling the maintenance and repair buildings at both locations, as well as enlarging the power production facilities, the boat-loading equipment and pellet stockpile area.

It is estimated that the expansion will be completed by mid-1963.

LINDE TO SUPPLY ARMCO PLANT WITH OXYGEN

△ Linde Co., Division of Union Carbide Corp., announced the signing of a contract with Sheffield Division, Armco Steel Corp., Linde will supply up to 100 million cu ft of oxygen per month to Sheffield's Houston Works.

The oxygen will be produced by a new plant, which Linde will build and operate in the Houston ship channel area. Linde will also construct a pipeline to deliver the required oxygen to Sheffield's mill.

STAMCO FORMS NEW SALES ORGANIZATION

△ Stamco, Inc. has announced the formation of Stamco Sales, Inc.

Offices have been opened in Cleveland, Ohio, Chicago, Ill., Detroit, Mich., and Chatham, N. J.

Prior to the formation of this new company, the products of Stamco had been sold through a network of sales representatives and machinery dealers.

AMSLER MORTON GETS SOAKING PIT CONTRACT

△ Contract for new soaking pits at the Buffalo Works of Republic Steel Corp. has been awarded to Amsler Morton Co., Division of Textron, Inc.

The new soaking pits are of the one way fired type, equipped with all metallic recuperators for heat exchange rather than the tile and metallic style of recuperators formerly used. They are the first of this type to be used at Republic's Buffalo Works. Completion is scheduled for November, 1960.

LOWEST COST INSURANCE

(ONLY 3/10¢ PER BRICK!)

— Assume the cost of firebrick to be about $175.00 per thousand.*

— Figure about 350 pounds of bonding mortar per 1000 brick.

— Difference in cost between 2nd best mortar and *SUPER #3000, the "NO EQUAL" mortar,* is about $17.00 per ton, or *3/10¢ per brick!*

— ***Only 3/10¢ per brick*** **for maximum insurance against expensive joint failure and resultant down-time.***

— ***Only 3/10¢ per brick*** **for maximum insurance against high maintenance labor and brick replacement outlay.***

Using SUPER #3000 costs *far less in the long run—far less* considering the labor and material replacement necessary when ordinary mortars fail.

SUPER #3000, the "NO EQUAL" mortar, is the lowest cost insurance you can buy. WRITE FOR SUPER #3000 SERVICE REPORTS, TECHNICAL DATA, FREE SAMPLE.

* *Cost of SUPER 3000 "insurance" is only 1/60 the cost of the brick! On carbon, chrome, insulating, high alumina and other more expensive brick, "insurance" can be as little as 1/200 the brick cost!*

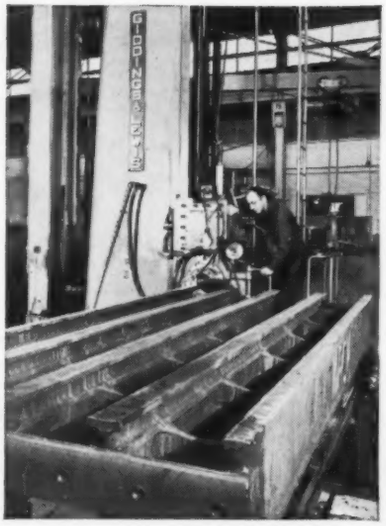
R&Q

REFRACTORY & INSULATION CORP.

136 WALL STREET • NEW YORK 5, N. Y.

Sales Offices: Chicago, Ill.; Cleveland, Ohio; Bryn Mawr, Pa.; Newark, N. J.; Buffalo, N. Y.

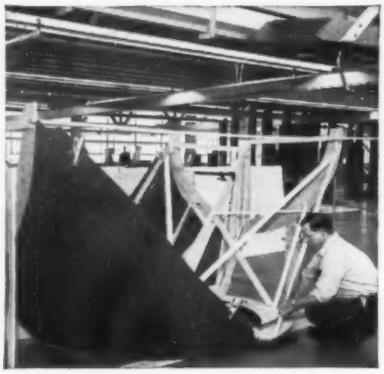
Manufacturers of Castable and Bonding Refractories; FURNACE BLOK; Blankets, Block, Plastic and Fill Insulations.



Reversible center section for 13 foot, 2 inch wide pallet being machined on horizontal boring mill. End section must be held to close tolerances to receive axles, which are pressed into place.

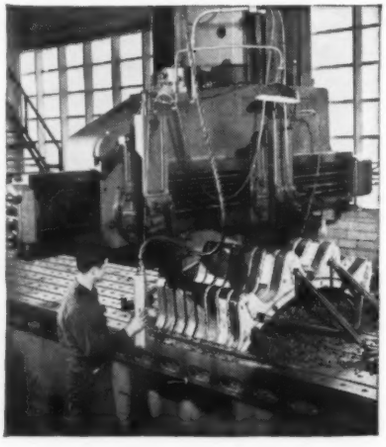
Wheel body for pallet drive on 26-foot vertical boring mill. The edge to which gear teeth are to be attached has already been machined, and the drive shaft hub is being bored.

A pre-installation test of circular sinter cooler in Dravo's Neville Island yards. Method of dumping the pans can be seen at the right rear. This particular feature of the Dravo-Lurgi cooler prevents excessive sinter breakup.



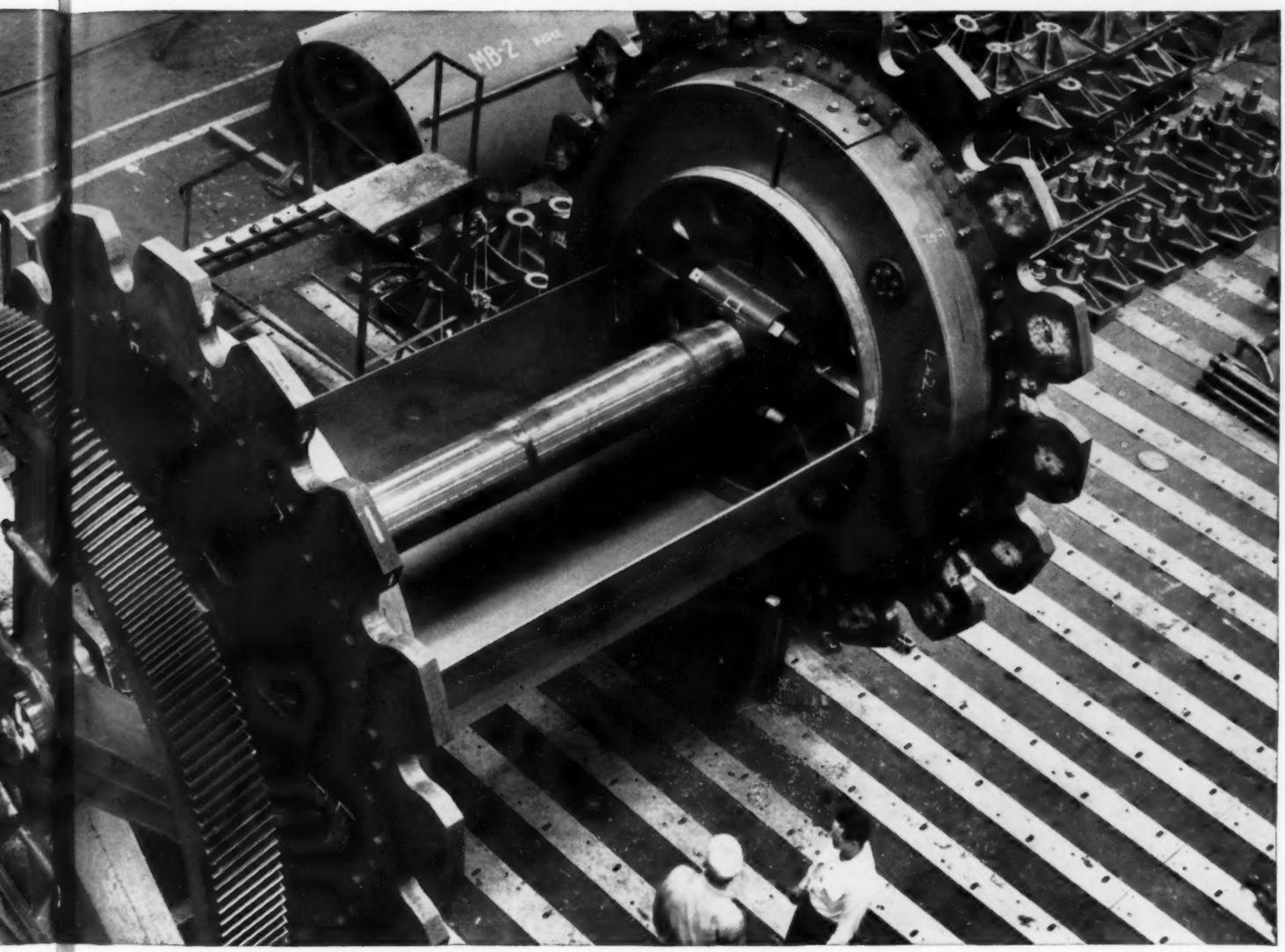
Full size mock-up of duct work for a sinter cooler in Dravo's mold loft. This model will provide templates for actual fabrication.

Dravo machinist operates 26-foot bed planer which is machining a full set of sprocket teeth. This method gives rigid control of uniformity for a perfect fit.



Pre-assembly of main drive for world's largest sinter machine in Dravo's Neville Island shops. All dimensions are carefully checked in this operation. Note partially assembled torque tube, a design feature which maintains accurate sprocket tooth alignment.

HOW DRAVO BUILDS SINTER MACHINES



Research and design begin the process. At Dravo's Research Center, sintering characteristics of ores to be used are determined . . . these form the basis for the final design. Through an exclusive licensing agreement with the Lurgi Company, Dravo incorporates sinter machine features developed by Lurgi modified to suit American standards.

Next comes fabrication of the machine itself, precision built in Dravo's own shops. And, finally, the erection of the complete facility.

This kind of single responsibility, including research, fabrication and engineering-construction, produces sinter plants that perform to specifications—on time. For complete information, write or phone Dravo Corporation, Pittsburgh 22, Pennsylvania.

DRAVO
CORPORATION

Morgan Crane selected for wide mill expansion program

This Morgan stripping crane was recently installed at Alan Wood Steel Co. in Conshohocken, Pennsylvania, in connection with their wide mill expansion program. Advanced features such as auxiliary hoist, stool breaker, 400-ton stripping capacity and traditional Morgan efficiency have been included in this universal type ingot stripping crane.

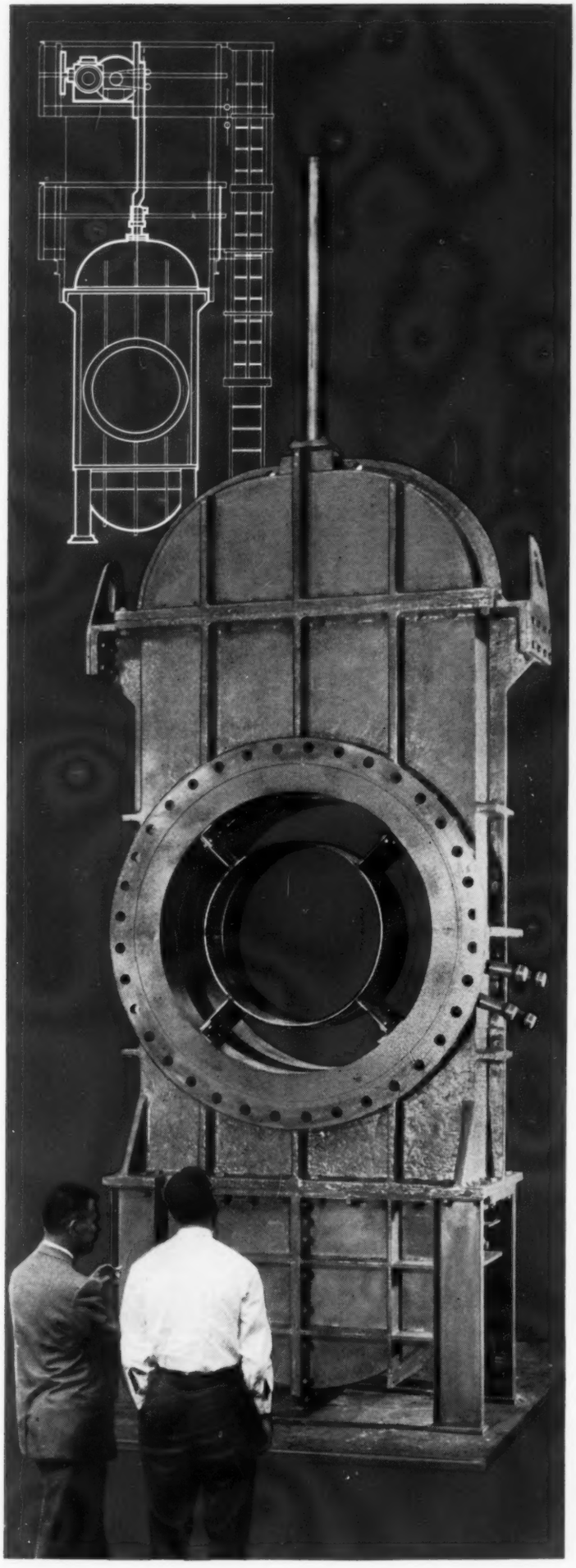
For large tough jobs where efficiency and dependability are a *must*, Morgan cranes pay off time after time. This is one of the reasons Morgan Engineering gets so many repeat orders from its customers.

If cranes are included in your expansion or modernization plans, be sure to get in touch with the Morgan people.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, blooming mills, structural mills, shears, saws, auxiliary equipment and welded fabrications.

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO BOOTHS 138 AND 139



NEW

fastest way of changing blast furnace stoves

BAILEY

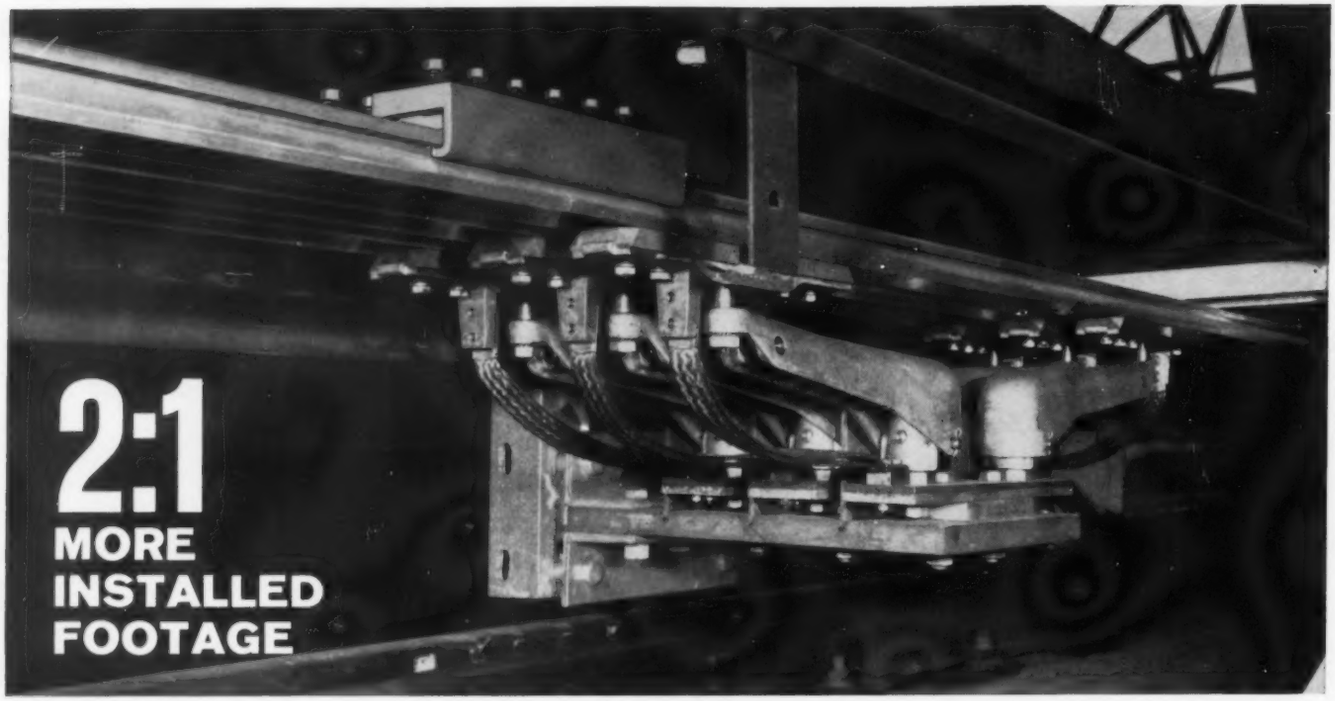
WATER-COOLED GAS BURNER SHUT OFF VALVE

Full Open to Full Closed in 11 Seconds

Valve disc and body are water cooled to prevent overheating while the stove is on blast. Motor-operated drive unit is located on a platform above the valve, well clear of stove heat. This valve is bolted tight to the burner and stove saddle flange, thus preventing leaks at the burner. *Write for Bulletin GB-100.*

WILLIAM M. BAILEY COMPANY

1221 BANKSVILLE ROAD, PITTSBURGH 16, PA.



Inverted V-Type conductor extrusion gives protected contact surface. Collector design provides for low current density—minimizes arcing and heating.

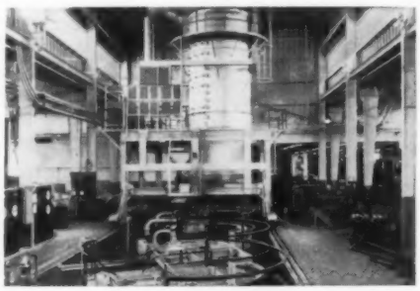
SUPERIORITY OF DELTA-STAR INTEGRATED DESIGN PROVEN BY OVERWHELMING CUSTOMER ACCEPTANCE

Operating in all kinds of atmospheres, more footage of *fully engineered* Delta-Star Integrated Aluminum Crane Conductor-Collectors are installed than all competitive makes combined.

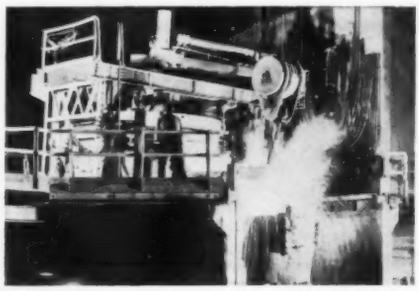
Delta-Star aluminum systems are easily installed, space-saving, and are corrosion-resistant. They eliminate the need for copper boosters, and reduce voltage drop. In the high ambient and corrosive conditions typical of blast furnaces, ship yards and other industrial applications, Delta-Star systems have provided efficient performance with low maintenance.

Integrated Aluminum Systems are available with continuous ratings of 500, 1000, 2000, 3000, and 6000 amps. For special applications, bronze and copper systems also are available with ratings from 450 to 2000 amps. For more complete information on the finest *fully engineered* crane conductor systems available, write to *Delta-Star Electric Division, H. K. Porter Company, Inc., 2437 W. Fulton Street, Chicago 12, Illinois.*

Ship yard installation defies extremely corrosive salt air.



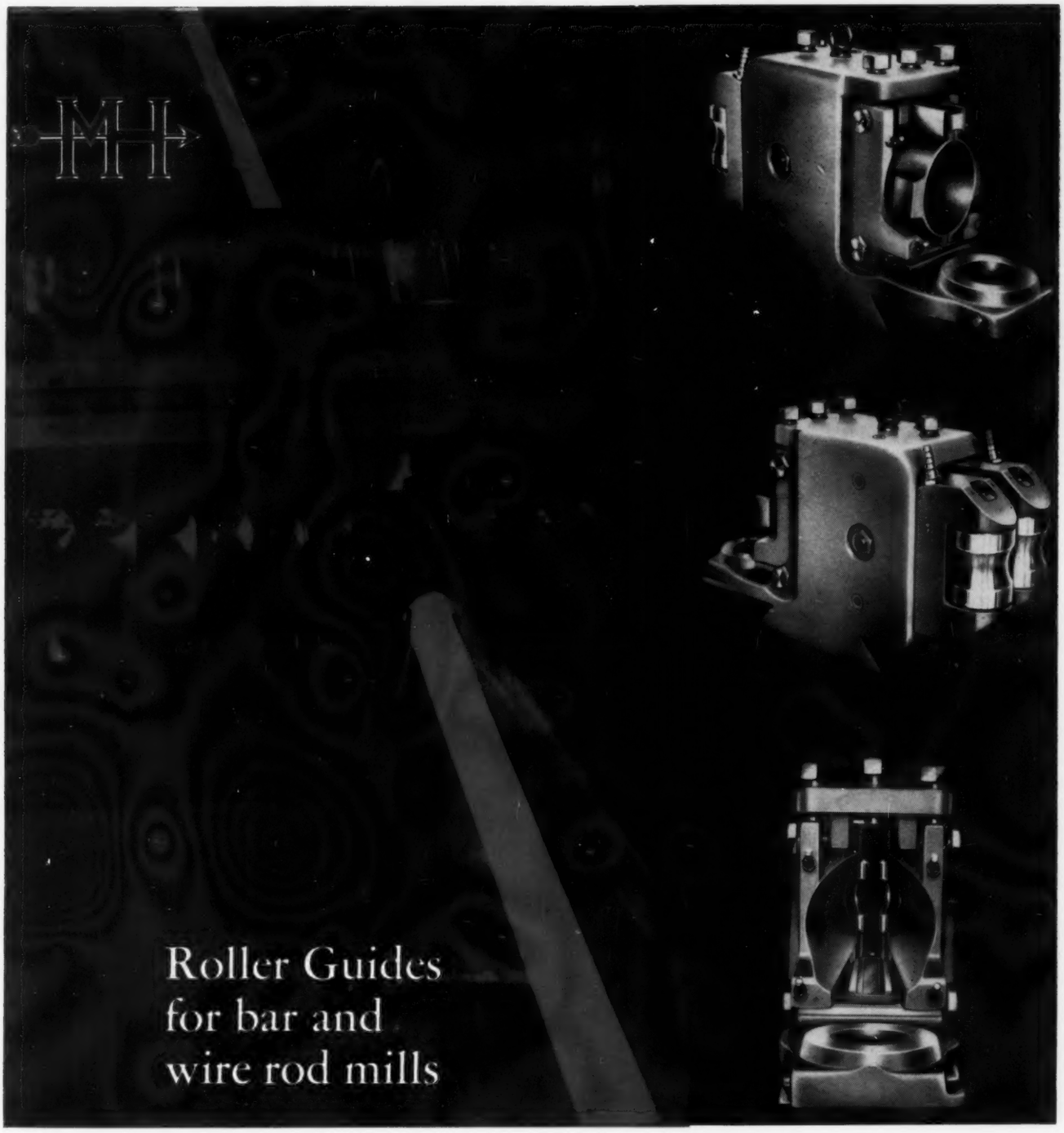
Traveling gantry type furnace at a mid-western steel treating company.



Blast furnace installations withstand high ambient temperatures.

DELTA-STAR ELECTRIC DIVISION PORTER **H. K. PORTER COMPANY, INC.**

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.



Morgårdshammar roller guides can be used for many sections such as leader and break-down ovals, squares, hexagons and octagons.

They can handle dimensions from about 3/16 in. (5 mm) round up to nearly 8 in. (200 mm).

You will obtain the following advantages with MH roller guides:

- INCREASED ACCURACY
- LESS SCRAP AND COBBLES
- REDUCED OPERATING COSTS
- INCREASED OUTPUT

For further information please apply to us for catalogues.

P.S.
In Scandinavia every bar and wire rod mill uses Morgårdshammar roller guides.

Sole agent for the U.S.:
K. W. Atwater Engineering, Inc.
124 Grant Avenue
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Swedish Quality

MORGÅRDSHAMMAR
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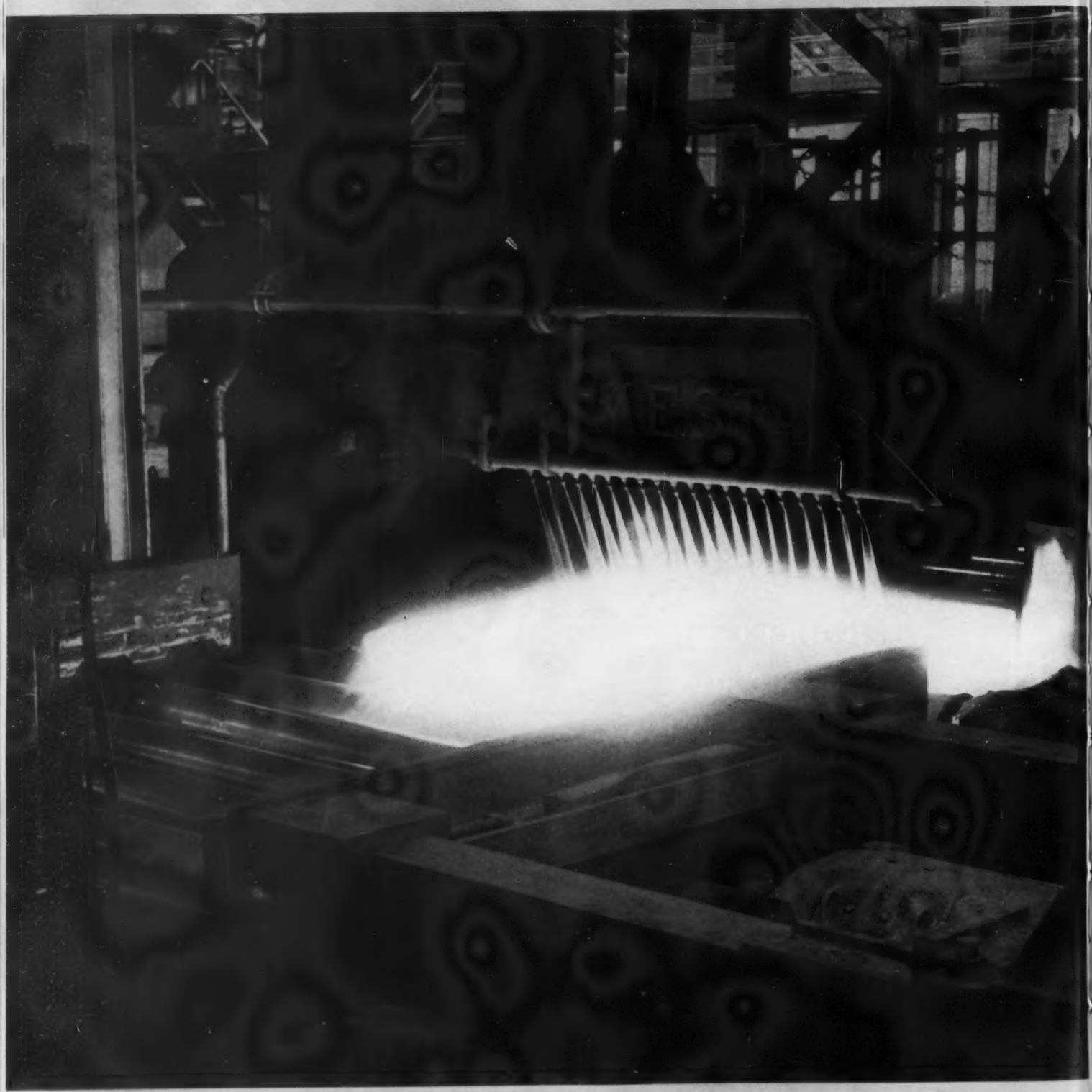
CENTRIFUGAL PUMPS

for high-pressure

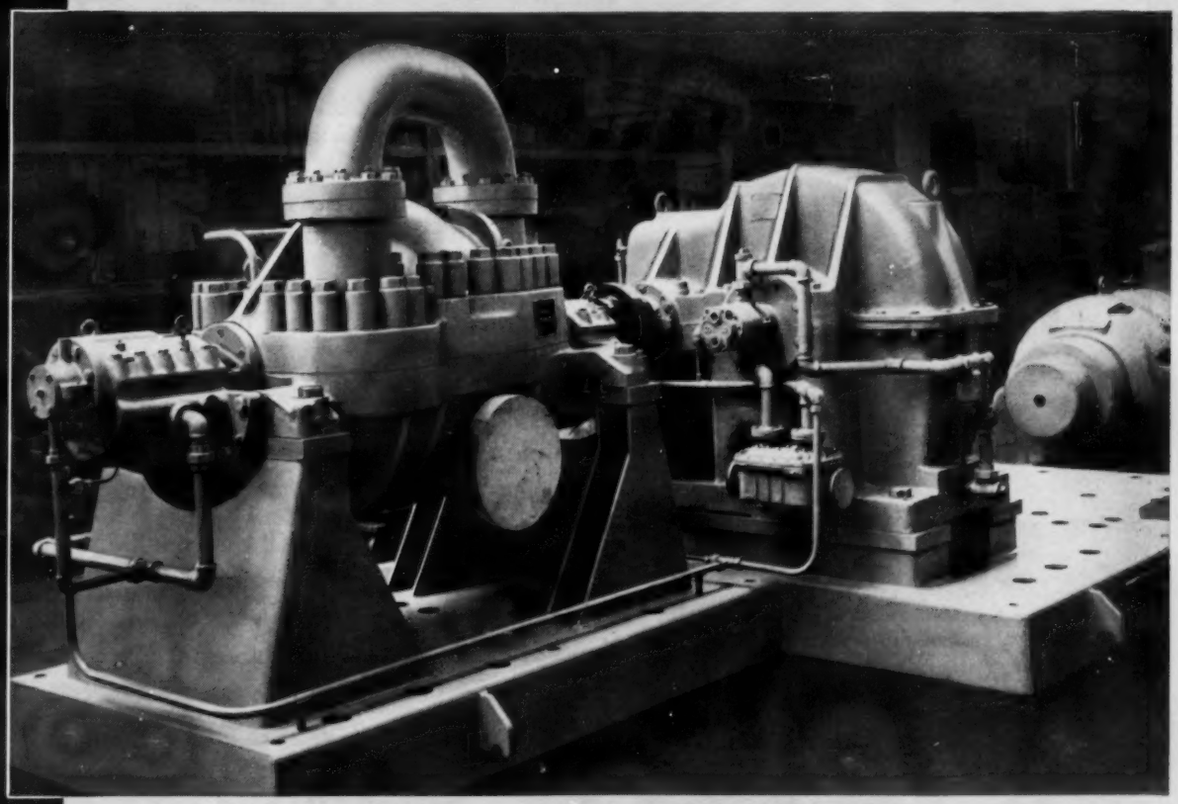


descaling at Lukens Steel

Latest successful technique of high-pressure descaling is now being performed in this modern steelmaking facility designed by Mesta Machine Co.

The initial high-pressure descaling operation uses De Laval split-case multi-stage pumps as shown in the photograph below. Each pump supplies cold water at 1000 gpm and 1600 psig. Electric motors rated at 1750 hp drive the pumps through speed increasers which raise the speed from 1200 rpm to 4250 rpm.

De Laval pumps also serve Lukens on a 1200 psig descaling system in another section of the Coatesville, Pa. mill.



One of several arrangements available for descaling service at pressures of 1000-1200-1600 psig and capacities to 2200 gpm.

DE LAVAL *Steam Turbine Company*

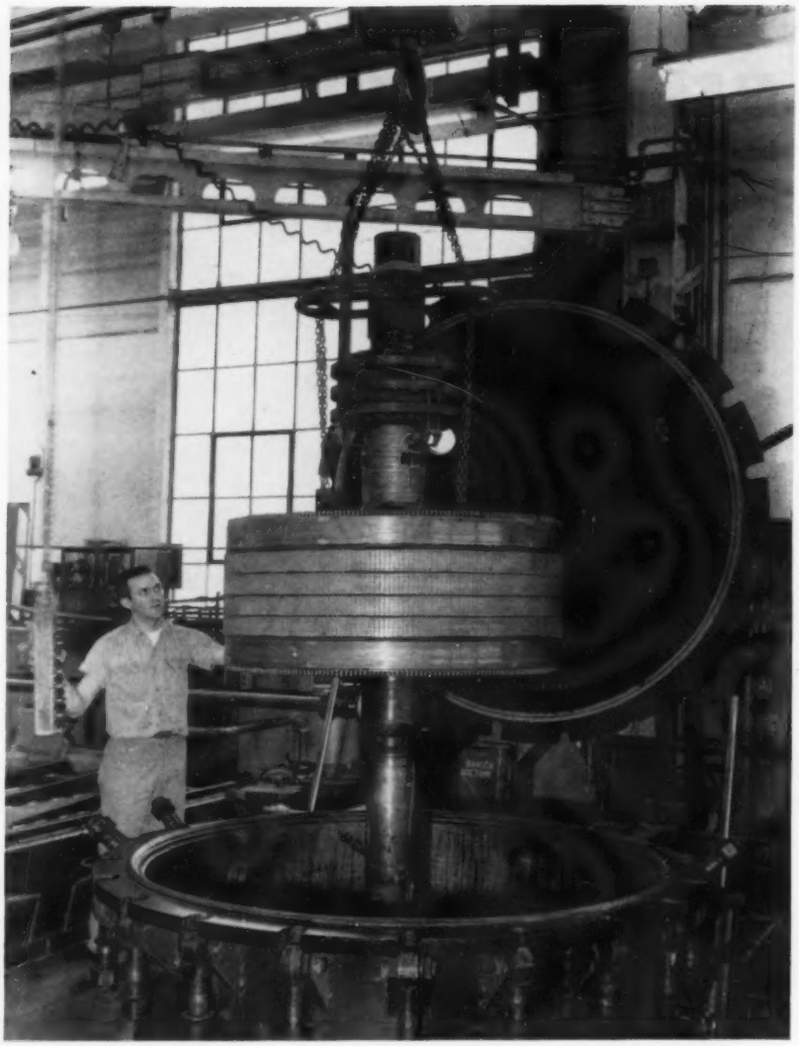
870 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

DL4

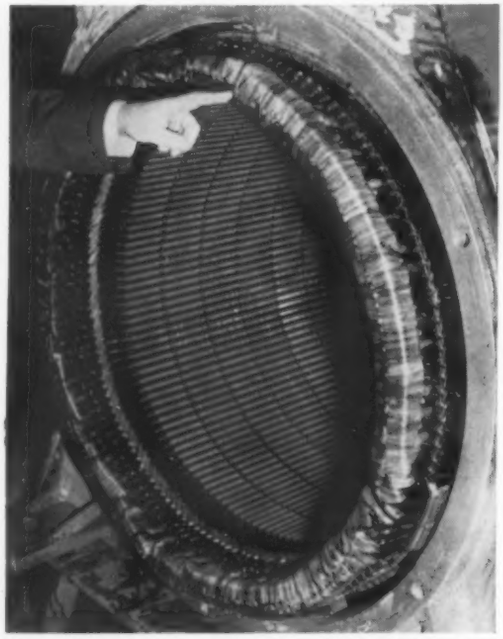
For maximum motor life...

NATIONAL VACUUM-IMPREGNATES THE COMPLETE MOTOR WITH EPOXY

National offers superb facilities for rewinding and rebuilding rotating electrical machines...such as this large vacuum tank used in impregnating insulations with super-strong Epoxy resins. Not only single coils, but complete rotor and stator assemblies for large motors are regularly handled in this equipment.



Rotor for 750-HP Motor is lowered into huge vacuum-pressure tank.



Complete stator assembly with NECCOBOND insulation system, after vacuum impregnation with Epoxy resins.

This process, used with the NECCOBOND insulation system provides these assurances of maximum service life:

- the insulation wall is completely void-free, with all interstices filled with resin to provide maximum heat conductivity.
- the exceptional mechanical strength and adhesion of Epoxy resin bonds the entire winding and core into a solid mass.
- uniform encapsulation provided by National's method of baking, insures high degree of protection against moisture.

Whether your electric coil and rebuilding needs are standard or special, you'll be sure of performance when you call in National Electric Coil. We tailor-make the coils to fit your needs, offer all types of insulation. For information call National's Columbus plant ...HUdson 8-1151...or check the nearest National field engineer.

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

NATIONAL COILS

National Electric Coil

COLUMBUS 16, OHIO • IN CANADA: ST. JOHNS, QUEBEC

DIVISION OF McGRAW EDISON

Precision Foil Mills in Action

at THE ANACONDA® ALUMINUM CO.

High quality aluminum foil as fine as .0002″ in thickness is now being rolled at speeds up to 2,000 feet per minute on these new 64-inch, four-high foil mills at Anaconda Aluminum, Louisville, Ky. Heavy demand for this material requires round-the-clock operation with minimum down time for maintenance.

Design features include a hydraulically operated roll stand to control pressure; a direct drive to permit variable work roll diameters ideal for research in producing metal foil; and X-ray equipment for automatic gauge control.

Contact PITTSBURGH for all your requirements in rolling mill equipment.

PITTSBURGH

ENGINEERING & MACHINE DIVISION

Pittsburgh Steel Foundry Co., Textron Inc.

564 FORBES AVE. PITTSBURGH 19, PA. • PLANTS AT GLASSPORT AND McKEESPORT, PA.

BLAST FURNACE GAS WASHING

Chemico P-A Venturi washers selected for 36 installations at 20 separate plants...

In furnaces from coast to coast, the Chemico P-A Venturi washer is proving the single most economical and effective method of cleaning blast furnace gases. Prior to the introduction of the Venturi blast furnace washer, the dust content of the gas from conventional primary washers ranged from 0.15 to 0.35 grains/CF. The Venturi washer can achieve results as low as 0.005 grains/CF.

Low initial cost, inexpensive installation and virtually no maintenance are the more obvious economic advantages of Venturi blast furnace washers. In addition, however, Chemico Venturi washers require very little water—one-third as much as conventional washers—and permit complete recycle.

They are rugged units which have proved their reliability and long life in actual working furnaces. Also important is their ability to handle wide fluctuations in gas volume without sacrificing cleaning efficiency. With 36 units now in operation or on order, you can be certain of proven performance with a Chemico P-A Venturi washer.

If you are considering the installation of gas cleaning equipment in a blast furnace, a Chemico representative would be pleased to show you the kind of top-performance job you can expect from a Venturi washer. And remember, Chemico handles the complete job... PLANNING, DESIGN, ENGINEERING, ERECTION and START-UP.

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Gas Scrubber Division
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New York 36, New York

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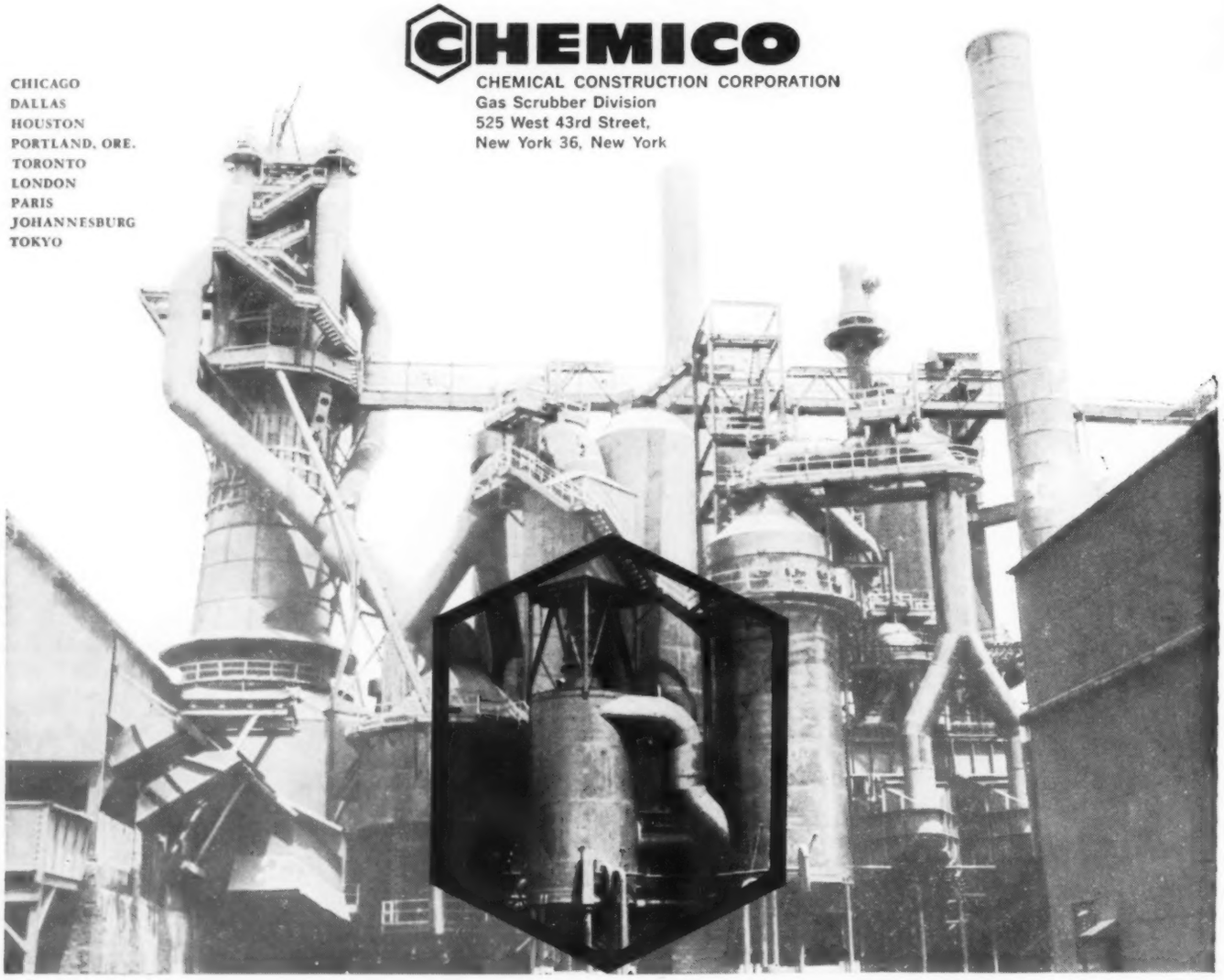

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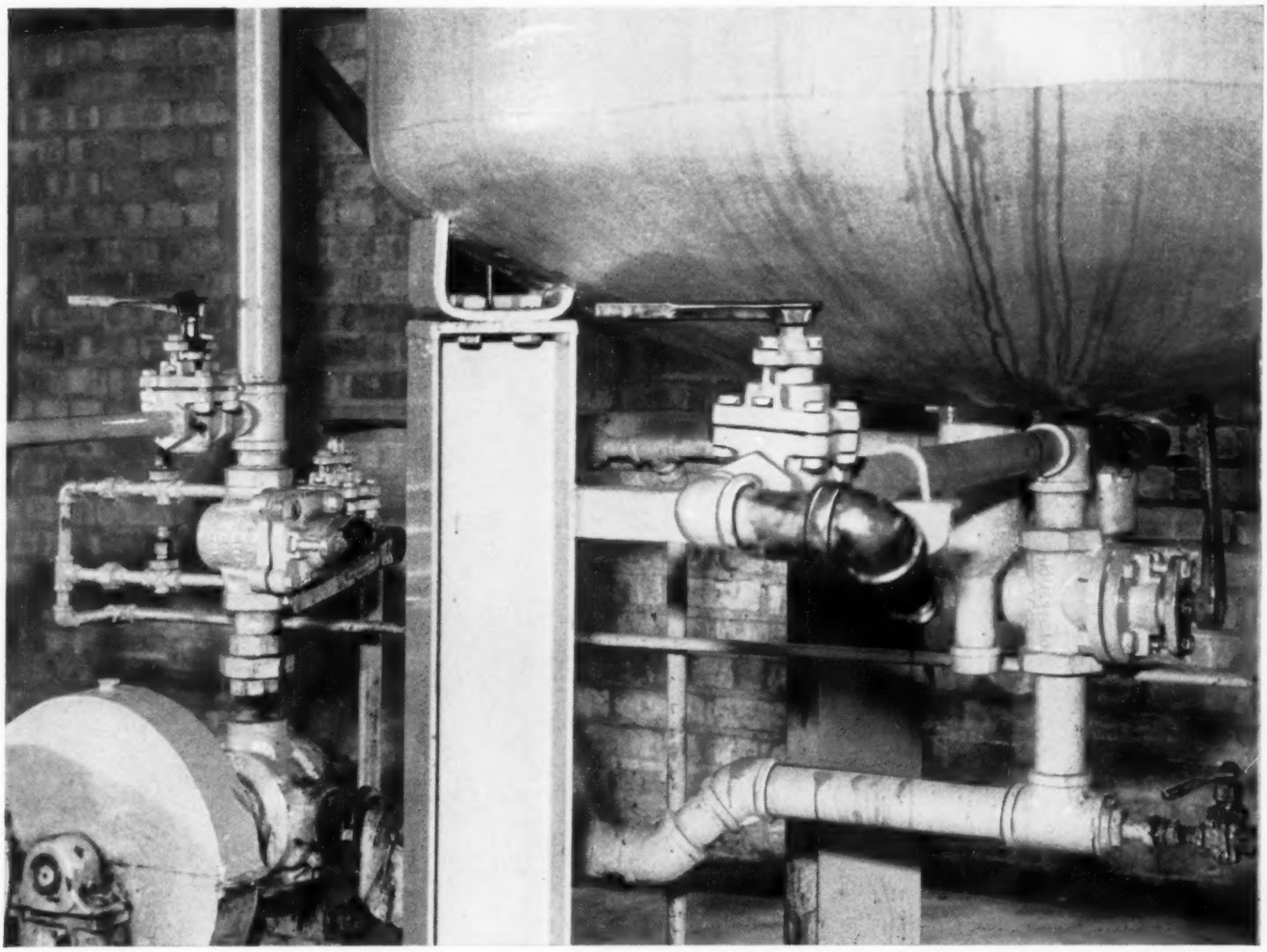
is yours with Homestead® Cam-Seald Quarter-Turn Valves. The Homestead CAM is the key to the simplicity and effectiveness of these valves. The cam



limits full operation to a quarter-turn and automatically provides drop-tight shut-off by pressing tapered plug firmly into the valve body. This cam also holds plug and body in close contact for added protection of sealing surfaces. When you specify Homestead, you get longer valve life and dependable, low-cost-per-year service . . . proved by over sixty-eight years in all types of industry. Mail coupon for complete information.

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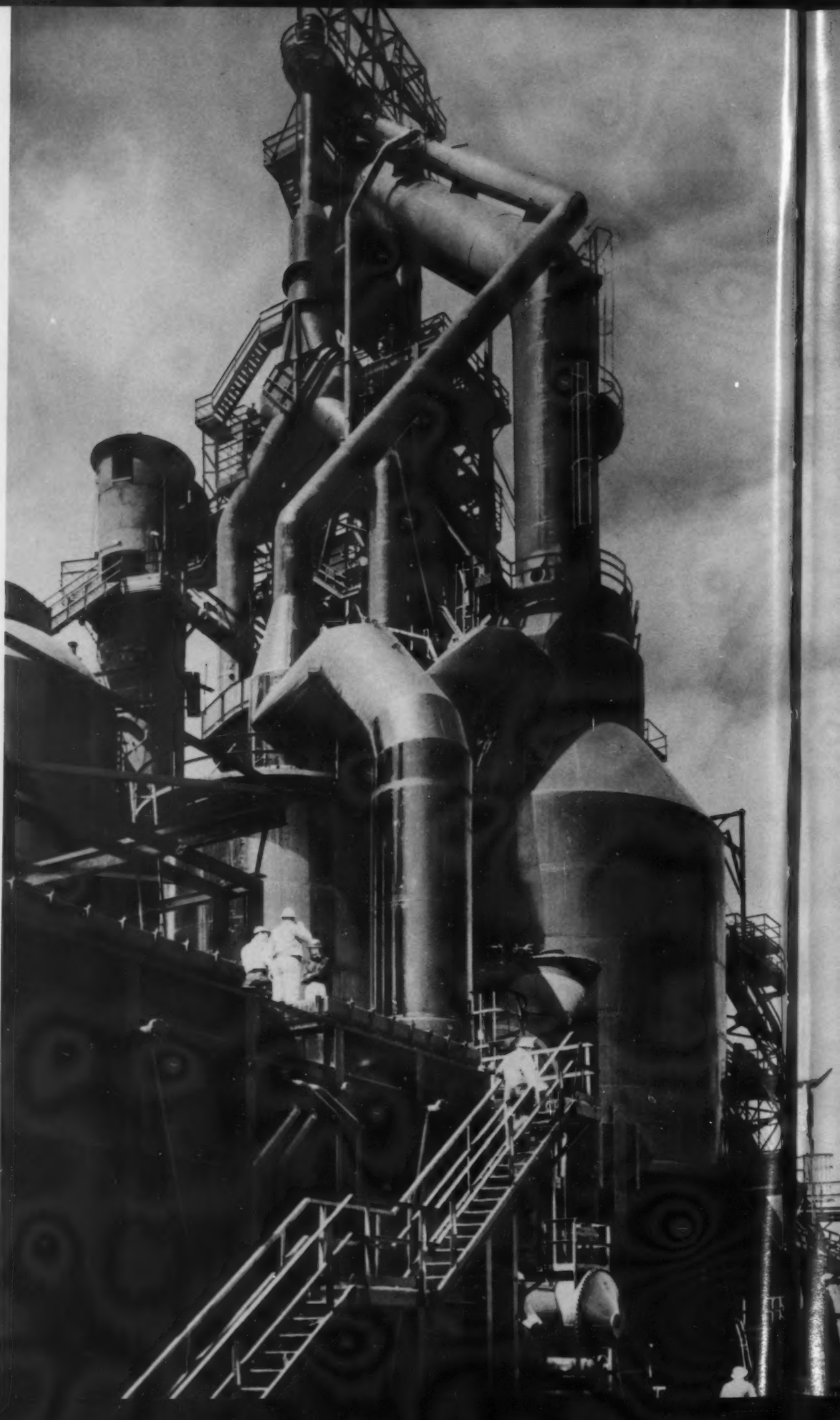
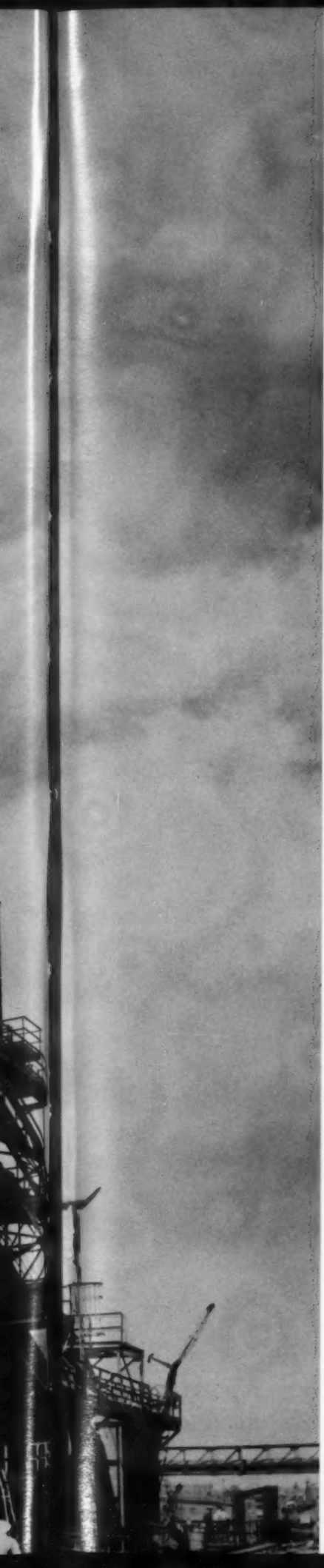


■ This is Furnace "A" at Great Lakes Steel Corporation's Zug Island plant — the first furnace in the world to cross the "30-foot line". Its hearth diameter is 30 feet, 3 inches.



MEETING THE COPPER NEEDS OF A GIANT

Furnace "A" of the Great Lakes Steel Corporation is *the* giant this side of the Atlantic—the first furnace in the world to cross the 30-foot barrier.

This magnitude justifies the special pride NBD feels about its contribution as one of the suppliers of Furnace "A" copper . . . a two-part contribution:

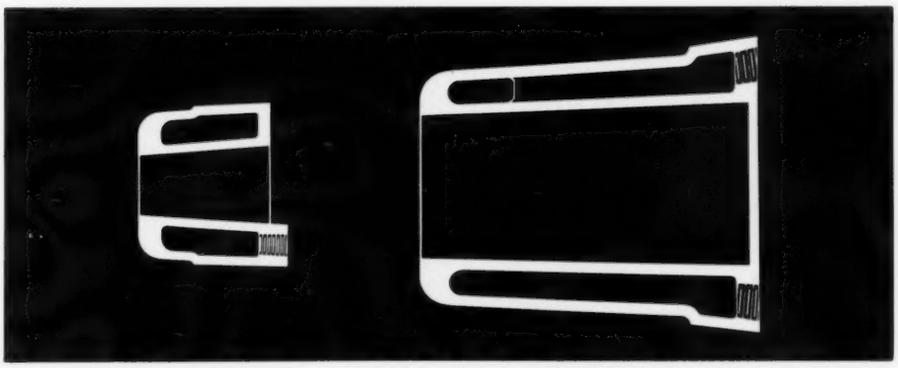
Customized Conductivity: NBD is recognized as the industry's leading advocate of this concept (reported here earlier this year).

At the Zug Island plant, the concept was put to use on monkeys and tuyeres. Working hand in glove, Great Lakes engineers and operating personnel and NBD copper specialists determined that a 90% minimum conductivity for monkeys would minimize "cutout". They also determined that, for the tuyeres, a controlled lower-conductivity copper with higher abrasion resistance would give adequate thermal flow while providing the necessary wear resistance, particularly at the nose.

These two distinct copper grades, customized to operating environment, have produced the desired results.

Quality Production: In view of its extensive manufacturing facilities, which have been supplying high-quality copper castings to the steel industry for more than 80 years, NBD won a berth as a supplier of monkeys and tuyeres for Furnace "A".

Put this combination of product engineering and quality production to work on all your blast-furnace copper needs. Through "customized conductivity" get the *right copper grade* and have veteran specialists cast it for you. You'll get the lowest possible copper cost per ton of iron produced. *Call us about it.*



NBD monkeys used in Furnace "A" (left) are cast of 90% minimum conductivity copper. NBD tuyeres (right) for Furnace "A" are giving long service life because they are cast of controlled lower-conductivity copper that has better abrasion resistance on the nose. These *two* grades of copper emphasize importance of NBD's "customized conductivity" concept.

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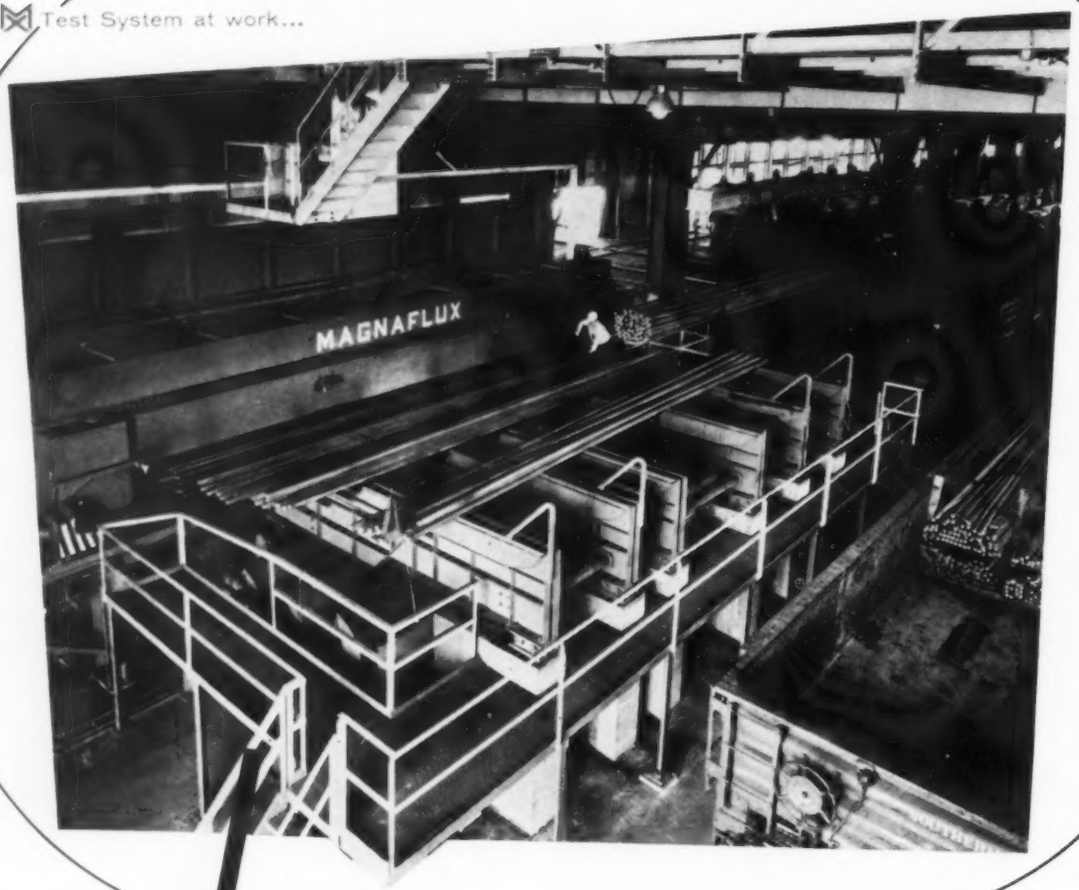
Another MX Test System at work...



Another Magnaglo Billet Conditioning Installation

This complete Magnaglo system was designed and produced by Magnaflux Corporation. It is just one example of Magnaflux ability to engineer and fabricate complete automated handling and testing systems for the steel industry.

A well-integrated Magnaglo inspection and handling system gives you better, more complete, control of billet quality from conditioning. And you can control the Magnaglo sensitivity to identify only the seams you want to scarf. This makes possible increased mill yield, substantially reduced billet conditioning costs, and consistently higher quality in the semi-finished state.

More and more mills are taking advantage of the years of experience gained by Magnaflux, the pioneer developer of magnetic particle test-handling systems for billets, tube rounds, and welded or seamless tubing and pipe. Now, how can we help *you*? Phone your local MX Field Engineer or write to Magnaflux Corporation, 7332 West Lawrence Ave., Chicago 31, Illinois.

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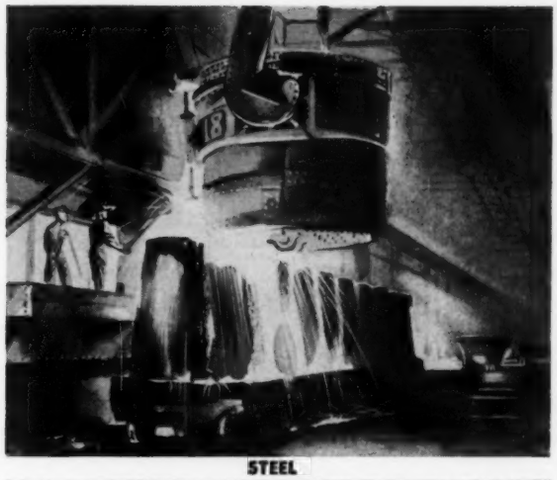
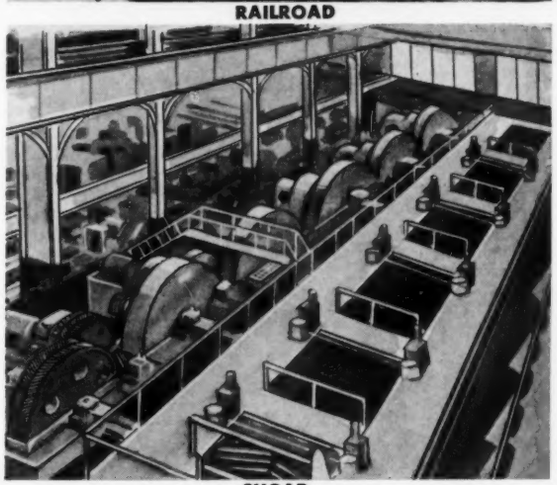
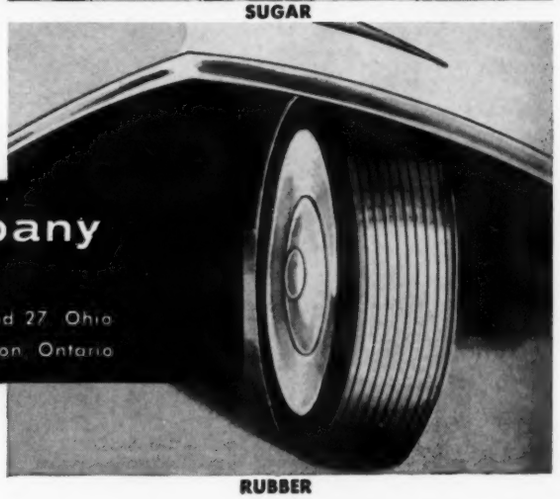


STEEL

RAILROAD



SUGAR



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CPA-50 (9-60)

General Electric—a pioneer in computer systems for all phases of business, industrial, scientific, engineering, and financial endeavor.

Personnel News...

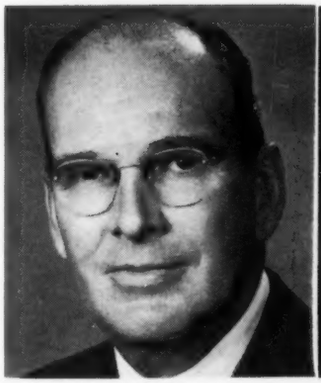
Edmund F. Martin was named president of Bethlehem Steel Corp. He succeeds **Arthur B. Homer** who was elected chairman, and who remains chief executive officer. Mr. Martin had been vice president in charge of operations of Bethlehem Steel Co., the company's principal subsidiary. Mr. Homer had served as Bethlehem president since 1945. He became chief executive officer in 1957 when the late **Eugene G. Grace** retired as chairman and chief executive officer. **John E. Jacobs** was elected vice president, steel operations, Bethlehem Steel Co.

James W. Kinnear, Jr., has been appointed vice president—steel producing divisions, United States Steel Corp. Mr. Kinnear was formerly executive vice president of the Tennessee Coal & Iron Division. He began his career with U. S. Steel in 1923, as a laborer at the Homestead District Works. He became assistant manager of operations—Pittsburgh District in 1940. In 1951 he was named general superintendent of the Edgar Thomson Works, Braddock, Pa., and in 1955, assistant vice president—engineering of U. S. Steel. Later that year he was appointed vice president—operations, Tennessee Coal & Iron Division, where he became executive vice president two years later.

Oscar Pearson succeeds Mr. Kinnear as executive vice president of Tennessee Coal and Iron Division. Mr. Pearson began his U. S. Steel career with TC&I. In 1941, he was transferred to the Gary, Ind., Steel Works as assistant chief metallurgist, and later became division superintendent—steel production. In 1952, he was transferred to Pittsburgh, as assistant general superintendent of Duquesne Works. A year later, he was given a similar position at the Youngstown Works. In 1954 he became general superintendent of South Works. In 1956, he was named general manager of operations—steel, for the corporation, and he became vice president—operations—steel in 1958. He was advanced to the position of administrative vice president—steel producing divisions in 1959.

Succeeding Mr. Pearson as administrative vice president—steel producing divisions of U. S. Steel is **John E. Angle.** He was formerly vice president, industrial engineering. Mr. Angle began his career in 1932 as a junior metallurgist at the Gary Sheet and Tin Mill of U. S. Steel. He served successively as a foreman in the cold reduction mill and as plant metallurgist before his appointment as assistant superintendent of the mill's sheet division in 1936. He became superintendent of the division three years later. Mr. Angle became assistant general superintendent of the Gary Sheet and Tin Mill in 1944, and was promoted to general superintendent in 1952. He remained in that position until his appointment as vice president, industrial engineering of U. S. Steel in 1955.

R. C. Colbaugh, Jr., succeeds Mr. Angle as vice president—industrial engineering of U. S. Steel. Mr. Colbaugh had been assistant vice president—industrial engineering. He joined U. S. Steel as a metallurgical observer at Duquesne Works in 1935. The following year he became an industrial engineer there, and in 1937 was transferred to Edgar Thomson Works in the same capacity. Mr. Colbaugh became plant industrial engineer at Edgar Thomson Works in 1939, serving in that capacity until 1942, when he was transferred to the general office of U. S. Steel in Pittsburgh as manager of the service bureau. He was named manager of the cost bureau in 1944, and assistant chief industrial engineer in 1950. Later he served as assistant to the

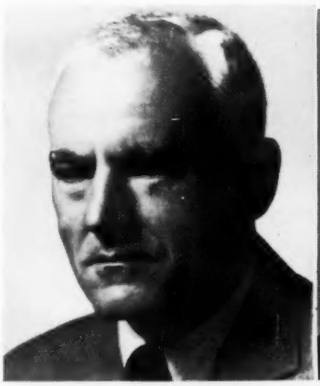


E. F. MARTIN

J. E. JACOBS

J. W. KINNEAR, JR.

OSCAR PEARSON

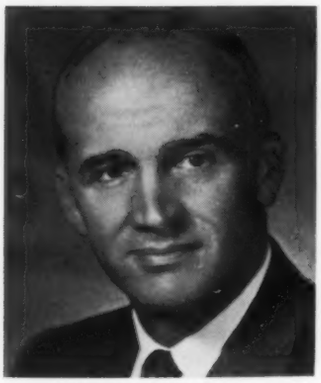


J. E. ANGLE

R. C. COLBAUGH, JR.

H. B. JORDAN

R. M. MILLER



S. J. GILLEN

C. W. CONN

general manager, operations—steel, before becoming assistant vice president—industrial engineering, in 1956.

Harvey B. Jordan has retired after 46 years of service with United States Steel Corp. Since 1959, Mr. Jordan has been executive vice president and chairman of the general administration committee of U. S. Steel. Mr. Jordan started with U. S. Steel in 1914 as an employee in the chemical laboratory of Central Furnaces and Docks of American Steel & Wire in Cleveland, Ohio. In 1915, he became clean-up foreman of the plant, rising to the post of superintendent in 1929 and joining the Cleveland operations offices in 1933. He was successively director of manufacturing practice in 1934, manager of operations in 1935, assistant to vice president in 1937, assistant vice president in 1938, vice president in 1939 and president of the Wire Division in 1950. In 1953, Mr. Jordan was named executive vice president—production for U. S. Steel and in 1959, executive vice president and chairman of the general administration committee.

Roland M. Miller was named to assistant superintendent of the Electrical Department at Republic Steel Corp's Massillon, Ohio, plant. He succeeds **W. D. Risher,** who retired recently after more than 45 years of service with Republic. Mr. Miller has been with Republic at the Massillon plant since 1941. He started as a substation maintenance man and was promoted to turn foreman in the Enduro Division in 1954. He has been general foreman of the plant's Furnace Division since 1957.

Stanley J. Gillen has been appointed general manager of Ford Motor Co.'s Steel Division. Mr. Gillen, who replaces the late **William J. Reilly,** has been assistant general manager of the division since 1956. Appointment of **C. William Conn** as assistant general manager also was announced. Mr. Gillen joined Ford in 1947 as a contract administrator in the defense products office. Mr. Conn has worked in the steel industry since 1923. He joined the Ford Steel Division in 1947, and was manager of open hearth and electric furnaces until 1954 when he was named division production manager.

J. C. "Jake" Siegle has retired after 47 years with The Youngstown Sheet and Tube Co. Mr. Siegle joined Youngstown as a mechanical engineer in 1913. He became a tube mill clerk, then general foreman and assistant superintendent at the Campbell, Ohio, Works. For three years, 1925–28, he was assistant works manager at the firm's Indiana Harbor Works at East Chicago, Ind., returned to the Campbell Works as superintendent of the tube mills and, in 1930, was named general superintendent of the Tube Division.

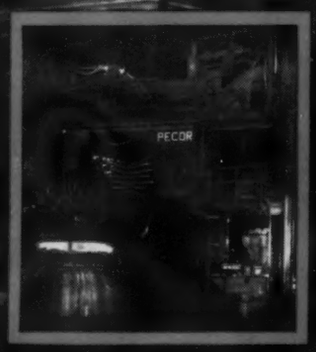
John J. Tomko was appointed supervisor and **Francis W. Schweitzer** was named assistant supervisor, Maintenance, Planning and Scheduling Department, The Youngstown Sheet and Tube Co.'s Indiana Harbor Works. Mr. Tomko joined the company in 1941 as a mason department laborer, later transferring to the machine shop as helper. Upon completion of his apprentice training he was made a machinist then assistant shop foreman. He was promoted to assistant supervisor of maintenance, planning and scheduling in 1957. Mr. Schweitzer joined Youngstown in 1939 as a laborer in the shipping unit of the Pipe Mill. After completion of his apprentice training he was assigned to the shops planning department.

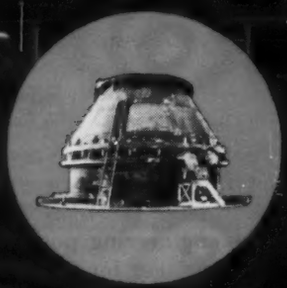
Dr. Robert B. Mears, who formerly served as director of U. S. Steel Corp.'s Applied Research Laboratory in Monroeville, Pa., has been appointed assistant vice president—applied research in Pittsburgh. At the same time, **Dr. J. G. Donelson** was named director of the Applied Research Laboratory, succeeding Dr. Mears. He began his association with U. S. Steel in 1946 when he joined the then Carnegie-Illinois Steel Corp. as manager of the research and development laboratory. Dr. J. G. Donelson, who served as assistant director, applied research, prior to his present appointment, began his association with U. S. Steel in 1937 as a

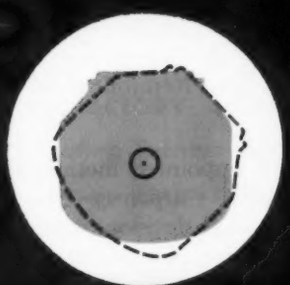
DR. R. B. MEARS

DR. J. G. DONELSON

in oxygen converters . . .







Top: 110-ton capacity furnace (L-D) with PECor-engineered smoke hood and post crane, at McLouth Steel Corporation.

Center: World's largest oxygen furnace (L-D) during assembly, for Jones & Laughlin's Cleveland Works.

Bottom: All PECor drives are soundly made for assured trouble-free service.

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physical chemist for the Carnegie-Illinois research laboratory in Pittsburgh. He progressed through various research jobs as senior chemist, research associate, supervisor of research associates, and assistant director, applied research, until he was appointed to his present position.

William I. Norman has been named manager of the Zanesville Works of Armco Steel Corp. He will succeed **Ross Little,** who has retired. Mr. Norman joined Armco's Zanesville Works in 1929 as a draftsman. After serving briefly in the Metallurgical Department as an assistant pyrometer service man, he was named an engineering draftsman in 1933 and senior construction engineer in 1943. In 1946, he was named assistant general foreman. He moved up to general foreman in 1949 and superintendent of operations in 1959.

James D. Campbell was named assistant sales manager, Mesta Machine Co. Mr. Campbell started his career with Mesta in 1947 where he served as construction manager of mill projects and sales engineer until his present appointment. He was previously employed by General Electric Co. and Patterson-Emerson-Comstock, Inc. At the same time, **Henry B. Grant** was appointed assistant to the executive vice president. He began his career at Mesta in 1907 working in the foundry and machine shops, and held various positions including superintendent of foundries and pattern shop during his service of over 50 years. Until his present assignment he was chief estimator. Succeeding him in that capacity is **William Muirhead.** He started his career at Mesta 30 years ago as a helper in the machine shop and served an apprenticeship to become a machinist. He was formerly assistant chief estimator.

Donald L. DeVries has been appointed sales manager of the Metal Products Division of Koppers Co., Inc. He has held various sales, production and administrative positions with Koppers and prior to his latest promotion, was manager of the division's Industrial Gas Cleaning Department. Mr. DeVries became associated with the Atlantic Refining Co. in 1939 and joined Koppers the following year. In 1946, he was named a sales engineer in the Philadelphia district. He started specializing in electrostatic precipitators at Baltimore in 1950 and was named manager of the Electrostatic Precipitator Department in 1953. When the division acquired a line of dust filters in 1955, Mr. DeVries became manager of the newly-formed Industrial Gas Cleaning Department.

Howard S. Bunn has been elected to the newly created office of vice chairman of the board and **Birny Mason, Jr.,** has been elected president of Union Carbide Corp. Mr. Bunn joined Union Carbide in 1922. He has been connected with several divisions of the corporation and was president of Union Carbide Plastics Co. from 1952 until 1953 when he became a vice president of Union Carbide Corp. He has been a director and member of the appropriations committee since 1954. Mr. Bunn was elected executive vice president and member of the executive committee in 1955 and president in 1958. Mr. Mason has been associated with Union Carbide since 1932. He held various positions in research and production with Union Carbide Chemicals Co. before he was made manager of the corporation's industrial relations staff in 1952. In 1955 he was made secretary of the corporation and the following year was named president of Union Carbide Development Co. He was elected a vice president of Union Carbide and appointed a member of the appropriations committee in 1957. In 1958 he was elected executive vice president and member of the board of directors.

George J. Peer was named to the newly-created position of sales manager—furnace products, Basic Inc. Mr. Peer assumes this post from his former position as midwestern district sales manager. Prior to joining the company in 1954 he was associated with Republic Steel Corp. in Canton, Ohio. **G. W. Edwards,** formerly central district sales manager, succeeds Mr. Peer as sales manager for the midwestern district. Mr. Edwards, before joining Basic in 1947, spent 14 years with Republic Steel in Buffalo, N. Y. **D. Bedell Baxter** moves from his service engineering position to succeed Mr. Edwards as sales manager for the central district in Cleveland, Ohio. Before joining Basic in 1939 he was associated with Crucible Steel Co. of America in Midland, Pa. He previously served with Pittsburgh Metallurgical Co., and Republic Steel Corp. at Buffalo.

John W. Keegan has been appointed metallurgist—hot and cold heading steels, Carpenter Steel Co. He will assist in field service and development of cold heading business. Before joining Carpenter, he was eastern sales manager for Herscott Corp. **Andrew R. Walsh** has been promoted to assistant metallurgist—high temperature alloys. Formerly in the Mill Metallurgy Department, his new position will involve servicing and promoting of high temperature alloys.

W. I. NORMAN

J. D. CAMPBELL

H. B. GRANT

D. L. DE VRIES

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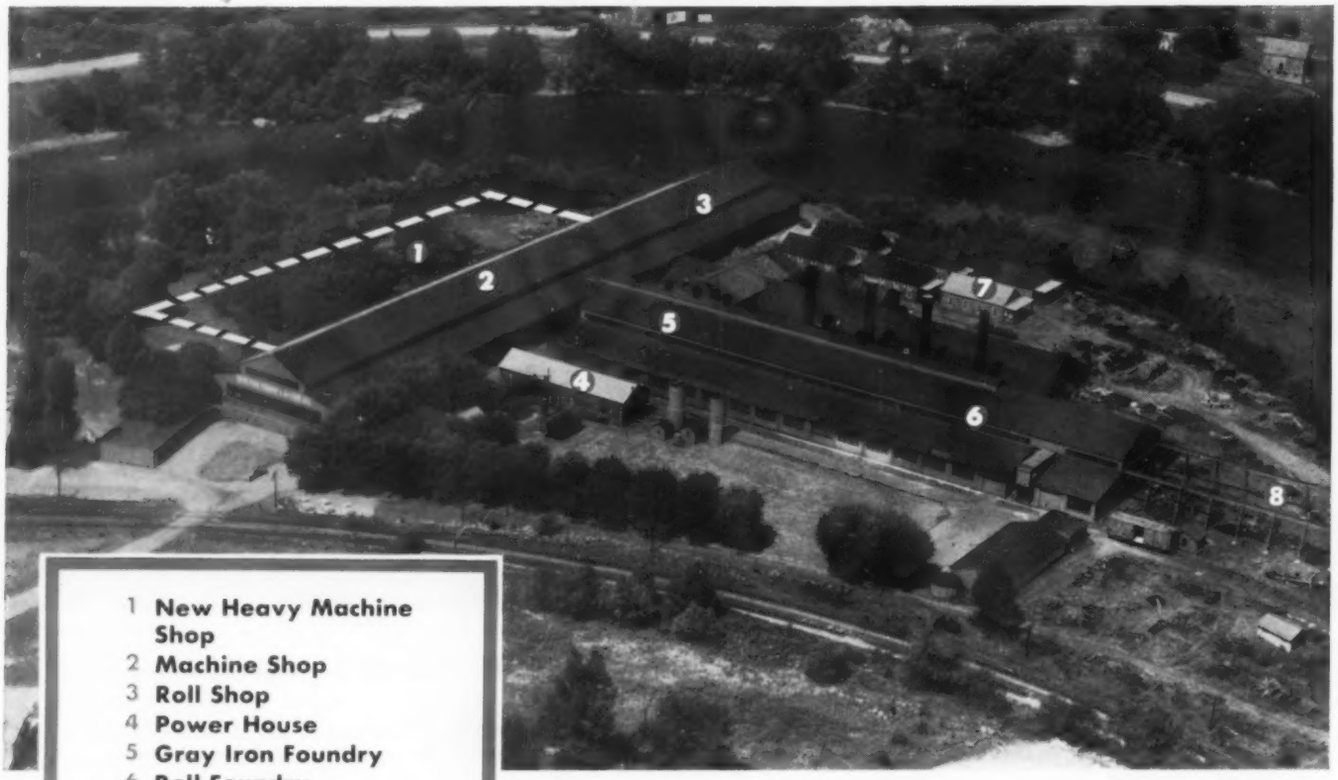
Hyde Park

Adds Facilities for LARGER and HEAVIER STEEL MILL EQUIPMENT



1 **New Heavy Machine Shop**
2 **Machine Shop**
3 **Roll Shop**
4 **Power House**
5 **Gray Iron Foundry**
6 **Roll Foundry**
7 **Pattern Storage**
8 **Scrap Yard**

ROLLS

Nickel Alloy Grain Rolls
Grain Rolls
Chilled Rolls
Nickel Chilled Rolls
Moly Rolls
Nodular Iron Rolls

All Grades Nickel Alloy Iron Rolls for Hot and Cold Rolling

ROLLING MILL EQUIPMENT

Bar Mills
Merchant Mills
Roller Tables
Stretcher Levellers
Sheet Mill Shears
Special Machinery
Sheet and Strip Mills
Pinion Stands
Reduction Drives
Roll Lathes
Machine Work

CASTINGS

Furnace Castings
Heavy Die Castings
Bases
Housings
Machinery Castings
Slag Pots
Heavy Tool Castings
Floor Plates

A new Heavy Machine Shop Building with 27,000 square feet is being built to augment erection and heavy tool facilities.

The main bay will have a 60 foot center aisle with capacity for 75 Ton Cranes.

Now, with expanded erection and engineering facilities, Hyde Park welcomes the opportunity to work with you on any of your equipment requirements.

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

Booth 470

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

The Mark of Quality

Foundry and Machine Company

HYDE PARK, WESTMORELAND COUNTY, PITTSBURGH DISTRICT, PA.

C. L. HOEBEL

J. A. SCHAEFER

DAVID NEILL

R. R. THOMAS

Prior to joining Carpenter last January, he was employed by Wyman-Gordon Co. and Vacuum Metals Corp. **Charles A. Divine, Jr.,** formerly on Carpenter's Technical Service Department and Stainless Steel Research and Development staffs, was promoted to assistant metallurgist—stainless steels. He will assist in servicing and developing new stainless steel business.

Charles L. Hoebel has been appointed Eastern regional manager of Elliot Co., a division of Carrier Corp. Presently serving as New York district manager, a position he will continue to hold. Mr. Hoebel succeeds **J. R. Lemmon,** who will retire early in 1961. Mr. Hoebel joined Elliot in 1952. Starting as a field engineer, he was appointed district manager of the New York territory in 1957.

J. A. Schaefer has been appointed Western territory representative for castings, rolls and machinery, by The Youngstown Foundry & Machine Co. He heads the J. A. Schaefer Co., Los Angeles, Calif.

David Neill has been appointed manager of roll grinder sales, Farrel-Birmingham Co., Inc. He succeeds **Robert J. Horning** who will transfer to the company's European office as assistant manager. Mr. Neill joined the company in 1942 and has for the past fifteen years been engaged in sales.

Waldo C. Portz, for 25 years general superintendent of Interlake Iron Corp.'s plant in Erie, Pa., has retired. He has been succeeded by **Ralph R. Thomas,** formerly assistant general superintendent. Mr. Portz joined Interlake Iron in Toledo, Ohio, in 1923 as a chemist. He served in a number of supervisory capacities and was blast furnace superintendent in 1935 when he was transferred to the Erie plant as general superintendent. Mr. Thomas became associated with Interlake in 1928 as an apprentice in the Blast Furnace Department of the Toledo plant, and by 1937 he was blast furnace general foreman. In that year he was transferred to Erie as blast furnace superintendent and six years later he became assistant general superintendent.

Raymond B. Kranes has been appointed sales manager of the Red Seal Electric Co.

Woodrow L. Hanson has been named general superintendent of the Reliance Electric and Engineering Co.'s Ivanhoe Division. Mr. Hanson was formerly with the National Electric Coil Co., for the past two years as manager of their plant in Quebec. **C. Porter Packard** was named manager of marketing services for the company, and **Clyde W. Seal,** Reeves product manager in Reliance's Marketing Division.

John C. Douglas has been appointed vice-president—operations and **David Swan** vice-president—technology of Union Carbide Metals Co., a division of Union Carbide Corp. Mr. Douglas has been with Union Carbide Metals Co. since 1934 and vice-president—technology since 1957. Mr. Swan has been with the corporation since 1946 and manager—planning since 1959.

R. A. Millermaster, Cutler-Hammer vice president—development, was recently elected to the firm's board of directors. He joined Cutler-Hammer as a test engineer in 1927. In 1930 he was appointed engineer in charge of Trumbull-Vanderpoel, then a Cutler-Hammer subsidiary. Three years later, 1933, he returned to Milwaukee headquarters as a development supervisor, a post he held until 1948 when he was appointed assistant manager of development. In 1952 he was named development manager and in 1956 was appointed vice president—development.

C. K. Waibel has been appointed assistant manager of the Coke Plant Sales Department in the Engineering and Construction Division of Koppers Co., Inc. He succeeds **O. H. Chambers,** who recently retired. Mr. Waibel joined Koppers in 1942 and has been a coke plant sales engineer since 1951.

Patrick W. Zilliacus was named general sales manager of the Western Precipitation Division of Joy Manufacturing Co. He was formerly manager of agency sales

C. K. WAIBEL

P. W. ZILLIACUS

for the division, and had been manager of the Standard Fan and Dust Collector Products Department of Joy at New Philadelphia, Ohio, from 1957 to 1959. Previously he was administrative assistant to the vice president and general manager, Industrial Division at the executive offices in Pittsburgh.

Adolph R. Schaub has been appointed vice president of manufacturing of L. J. Wing Mfg. Co., Division of Aero Supply Mfg. Co., Inc. He had been manager of manufacturing since joining Wing in January of this year. He was previously with M. W. Kellogg Co. where he served in project engineering, purchasing and production management capacities.

Thomas C. Pratt has been named president of the newly organized Pranell Machine Works, a heavy machine building and jobbing shop, for heavy machining and weldments. Mr. Pratt formerly spent seven and a half years as superintendent of shops at United States Steel Corp.'s Fairless Works. Previous to that he was with Jones & Laughlin Steel Corp. for 14 years.

Douglas D. Brien has been named president of the Ohio Gear Co. He succeeds **Harrison Browning,** who has been appointed chairman of the board, after serving 33 years as president. Mr. Brien has served as executive vice president since 1949.

Elwin E. Smith has been appointed general sales manager of Climax Molybdenum Co., a division of American Metal Climax, Inc. He succeeds **Lars Ekholm** who has been advanced to vice president of Eastern operations. Mr. Smith previously had served as manager of chemical sales, a post he held for two years. He joined Climax Molybdenum in 1955 as manager of lubricant development after more than ten years in the petroleum and chemical industries.

Jack McDonough has been named to the new position of assistant to the president of Meissner Engineers, Inc.

Frank H. Frandsen has been appointed manager of the Denver Colo., district office of The Falk Corp. He succeeds the late **Herman H. Klackner.** Mr. Frandsen became associated with the company in 1950 as an engineering trainee, and for the past three years has served as sales representative in the Denver territory. **Robert Rock** has been named his assistant.

E. O. Austermiller, formerly with National Tube Division, U. S. Steel Corp., is acting as consultant for Patterson-Emerson-Comstock, Overseas, Inc., on a project at Genoa, Italy.

Ralph J. Brady was appointed to the position of sales manager, Iron and Steel Division, Patterson-Emerson-Comstock. Mr. Brady was formerly project manager on the electrical installations at the Dravo sintering plant project, Interlake Iron Co., and the Koppers coke oven battery at The Youngstown Sheet and Tube Co.

Bruce W. Morrison has been appointed area sales manager for Westinghouse Electric Corp.'s Boston, Mass., district office. He joined Westinghouse in 1947,

EXECUTIVE REPORT #9

THEY BLAST BRIDGES BEFORE THEY'RE BUILT

Blast Cleaning Structural Steel Provides Big Savings

Prominent structural steel fabricating plants now blast clean all shapes and sizes of structural steel channels, angles, plates, bar and rod stock—in Wheelabrator cabinets.

The straight-line production made possible by Wheelabrator airless blast cleaning has improved manufacturing efficiency and reduced their cleaning costs substantially. And the shot-blasted finish has proven to be ideal for lasting surface protection of the finished structural members.

Wheelabrator's unequaled experience in descaling structural steel is at your service. Send for new informative bulletin No. 152-D. Write to Wheelabrator Corp., 396 S. Byrkit Street, Mishawaka, Ind. In Canada, P. O. Box 490 Scarborough, Ont.

WHEELABRATOR
AIRLESS BLAST EQUIPMENT

and his first assignment was sales assistant in the New York apparatus sales office. He became a sales engineer in 1952, specializing in apparatus or electric utility products.

Dr. Horace N. Lander has been named assistant director of research for The Youngstown Sheet and Tube Co. Formerly research supervisor for Jones & Laughlin Steel Corp. he was also employed by General Electric Co., and was a metallurgical group leader for Metal Hydrides, Inc.

James T. McCabe has been appointed lubricant development engineer for Climax Molybdenum Co. He previously had served as a sales engineer with Cities Service Oil Co. for 14 years, and in the sales department of L. Sonneborn Sons, Inc., petroleum refining company.

James W. Kirkpatrick was named assistant to the vice president—operations, Youngstown District, The Youngstown Sheet and Tube Co. He previously was assistant superintendent of the Brier Hill plant. **Robert H. Frushour** was appointed general superintendent of steel plant and the Struthers Works, from assistant superintendent, and **Jack F. Major** was named assistant general superintendent of steel plant and Struthers Works. He previously was assistant general superintendent of flat rolled and tubular products.

Jerome L. Lindberg has been promoted to superintendent of the Mechanical Department at Colorado Fuel & Iron Corp.'s Pueblo Plant. He was previously assistant to the director of mechanical maintenance.

A. H. Storch has been appointed manager of field sales of Crane Co.'s Industrial Piping Products Division. Mr. Storch formerly was manager of engineering sales. His successor in that position is **F. M. Schairer.**

Jack A. Henderson was appointed supervisor of the research and development section, Engineering Department, Garlock Inc.

Joseph S. Fragomeni was named superintendent of construction for The Youngstown Sheet and Tube Co.'s Chicago District. Mr. Fragomeni was formerly project manager for Chas. W. Cole and Son. Before that he was employed as staff engineer for the Structural Clay Products Institute.

George L. Stroman, Jr., has been named superintendent of the Flanging Department, Lukens Steel Co. **Charles H. Brown** was appointed manager of the Research Department, and **George L. Germain,** supervisor of development and training. Mr. Stroman, who has been with Lukens since 1949, had been assistant superintendent of the Clad and Alloy Department for the past six years. Mr. Brown joined the company in 1950, and was an engineer in the Application Engineering Department prior to his promotion. Mr. Germain had been with Chrysler Corp. in Detroit since 1953, most recently as placement supervisor of the management development program.

Roy K. Cannon is the newly appointed sales manager of the Electro-Alloys Division of the American Brake Shoe Co. Formerly Western district sales manager, Mr. Cannon joined the Electro-Alloys Division in

EXECUTIVE REPORT #30

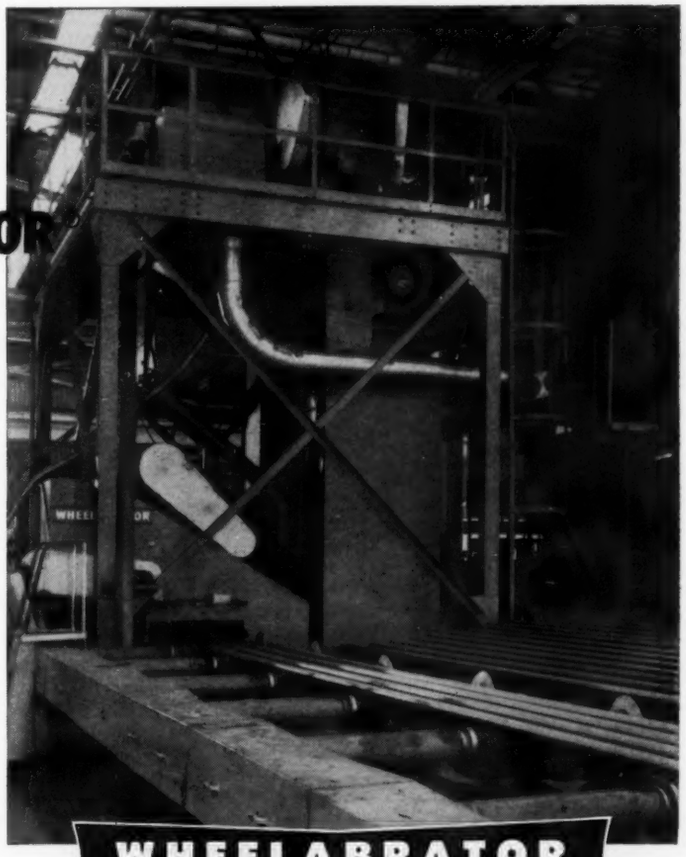
AUTOMATED DESCALING WITH THE WHEELABRATOR

The bar stock cleaning line in the new two million dollar Elyria, Ohio, Cold Draw plant of The Western Automatic Machine Screw Co., Div. of Standard Screw Co. utilizes one of six Wheelabrator descaling machines that have completely eliminated pickling in this modern plant.

On the bar line, the Wheelabrator enables one man to handle the entire operation, from receipt of bar bundles, through an unscrambler, transfer to feed roll conveyors, through the Wheelabrator, and out onto a storage rack in line with the draw bench. For over 16 months of operation, round, square and hex bar stock, up to 4½" diameter in 15' to 45' lengths, has been descaled without any of the old acid pickling headaches. In addition, Western Automatic reports that Wheelabrator descaling provides a definitely superior product for subsequent cold drawing.

How To Automate Your Bar and Wire Drawing Lines

Details of Wheelabrator's cost-saving descaling method are illustrated in Bulletin 148-D. Write to Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Indiana. In Canada, P.O. Box 490, Scarborough, Ontario.



WHEELABRATOR
AIRLESS BLAST EQUIPMENT

1948. He became a sales engineer in the Chicago territory in 1949.

Marvin L. Beck has been named manager of manufacturing for General Electric Co.'s High Voltage Switchgear Department. He succeeds **W. M. Anthony** who has been appointed manager of works utilities for G-E's Philadelphia switchgear departments. Mr. Beck has been manager of the Murfreesboro, Tenn., plant since 1957, when the Appliance Motor Department operations began there. Since joining the company in 1934, Mr. Beck has held engineering and management positions in Ft. Wayne, Ind., and De Kalb, Ill.

Donald J. Wallace has been named district sales manager for the Coffing Hoist Division of Duff-Norton Co. Mr. Wallace had been serving as district sales manager for the Coffing Hoist Division in New York. He formerly held the same position in Cleveland.

Charles S. Stock has been appointed to the post of manager of central marketing, American Air Filter Co., Inc. At the same time, **A. B. Ullrich, Jr.,** has been named manager of Engineered Air Systems Division.

Joseph A. Lamberger, has been appointed a staff industrial engineer, Industrial Engineering Department, Jones & Laughlin Steel Corp. Mr. Lamberger, who formerly was supervisor of the cost control system, will be responsible for coordinating the development and maintenance of standards for cost control programs.

Paul L. Schreiber, formerly a senior budget analyst, will assist Mr. Lamberger as a staff industrial engineer. Mr. Lamberger has been a J&L employee since 1939, when he started at the Pittsburgh Works Strip Mill as a clerk recorder. Mr. Schreiber joined J&L in 1935, as an industrial engineer at the Aliquippa Works. He joined the general office engineering staff in 1948.

J. C. Malone has been appointed assistant to the general manager of the Silicones Division, Union Carbide Corp. Mr. Malone comes to his new post from the Institute, W. Va., plant of UCC's Chemicals Co., where he was assistant superintendent. At the same time, it was announced that **C. T. Schieman, Jr.,** has been appointed general sales manager for the division, and **P. S. Manchester,** assistant general sales manager. Also, **R. S. Wishart** has been appointed manager, product marketing.

Obituaries

Edmund Foley, who for 28 years was a superintendent for the Rust Furnace Co., died July 10. Mr. Foley had been retired for two years.

George A. Rumsey, 89, chairman of the board of Rumsey Electric Co., died July 21. Mr. Rumsey, with his brother, Eugene, founded Rumsey Electric in 1895.

Stanley W. Ewing, 66, former sales representative for the International Graphite Electrode Corp., a subsidiary of Speer Carbon Co., died August 5.

"CLEVELAND" Billet & Structural SHEAR BLADES

Forty years of experience plus the HILL ACME guarantee of material and workmanship are your assurance of complete reliability and "know how" in producing CLEVELAND Alloy Grade billet and structural shear blades for shearing hot and cold metals.

We are the *only* manufacturers of both shears and shear blades for this application. The advantages of using CLEVELAND blades, produced by a shear manufacturer, are obvious.

THE HILL ACME COMPANY
CLEVELAND KNIFE DIVISION
1203 West 65th Street • Cleveland 2, Ohio

Polish metallurgical samples easier, better, more uniformly with . . .

SYNTRON

LAPPING-POLISHING MACHINES

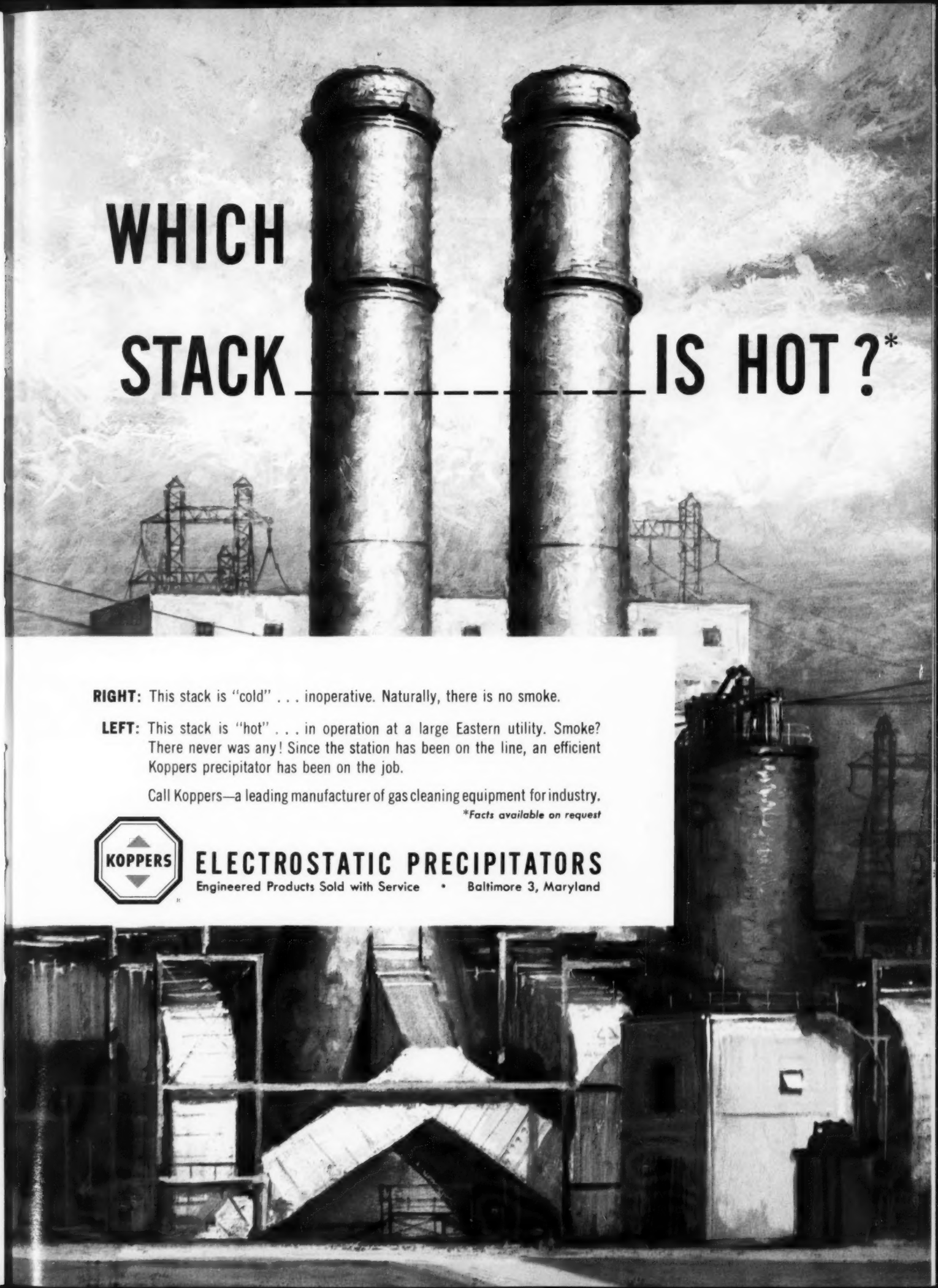
—whether it's one or a number of specimens to be polished, SYNTRON Vibratory Lapping-Polishing Machines will produce a metallographic finish for an electron microscope or brush analyzer examination.

Gentle, electromagnetic vibration moves the specimens smoothly around the pan, over abrasive cloth or felt polishing cloth. Both abrasive and felt cloths are removable.

SYNTRON Lapping-Polishing Machines are easy to install, easy to operate, easy to maintain.

Write for detailed literature today

SYNTRON COMPANY
Quality Equipment Since 1921
699 Lexington Ave. Homer City, Penna.



RIGHT: This stack is "cold" . . . inoperative. Naturally, there is no smoke.

LEFT: This stack is "hot" . . . in operation at a large Eastern utility. Smoke? There never was any! Since the station has been on the line, an efficient Koppers precipitator has been on the job.

Call Koppers—a leading manufacturer of gas cleaning equipment for industry.

**Facts available on request*

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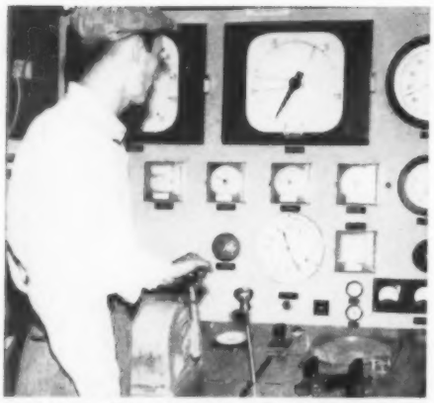
ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with Service • Baltimore 3, Maryland



Bristol Electronic Dynamaster* Potentiometers (top left on panel) and Bristol Metagraphic Miniatures (directly under Dynamasters) on control panel at Dofasco. Bristol instruments at Dofasco monitor such important variables as oxygen pressure and flow (current rate and total), lance position and lance cooling water temperature, flow and pressure and other temperatures.

**T.M. Reg. U.S. Pat. Off.*

Growth of oxygen steelmaking is one of the most exciting steel-industry advances during the past decade.

And Bristol instruments are playing an ever increasing part in this production revolution—from the first basic oxygen (L-D process) steelmaking plant on the North American Continent (see photos) to oxygen-using modifications of open-hearth furnaces, bessemer converters, and electric furnaces.

Here are just a few of the important variables Bristol instruments measure, indicate, record, or automatically control in modern oxygen steel plants: Oxygen pressure and flow (current rate and total), oxygen lance position, lance cooling water temperature, flow and pressure, fuel (coke-oven, natural gas, oil) flow, totalized flow and pressure—as well as complete telemetering and dispatching-center instrumentation for both fuel and oxygen pipelines.

A complete line of Bristol pyrometers—radiation, thermocouple and resistance models—and accessories are offered for every temperature range ... from −125° F to 5000° F... in every kind of steel plant.

Get complete data! Before committing your steel plant to *any* modernization program, find out how *Bristol* can solve your instrumentation problems. Write: The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

O.30

Instruments for oxygen steelmaking... by Bristol

First basic oxygen steelmaking plant in North America at Dominion Foundries and Steel, Ltd., (Dofasco) at Hamilton, Ontario, Canada. Oxygen plant in foreground; steelmaking plant in distance. Bristol instruments play an important part in this pioneering operation.

BRISTOL ... for improved production through measurement and control

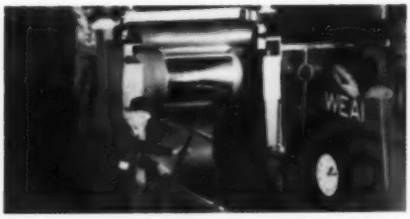
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

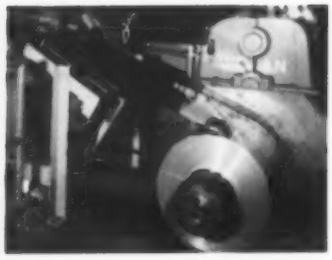
Visit us at Booth 623 at the Iron and Steel Show

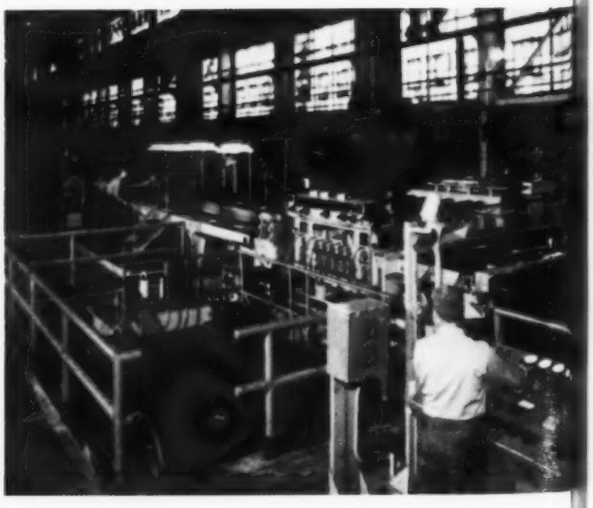
What's ahead for the Steel Industry?

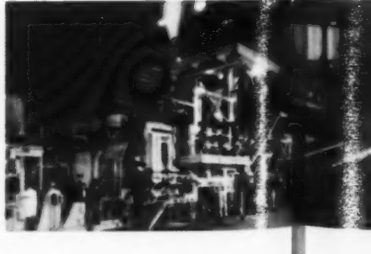
A decade of growth,

but with greater challenges to be met

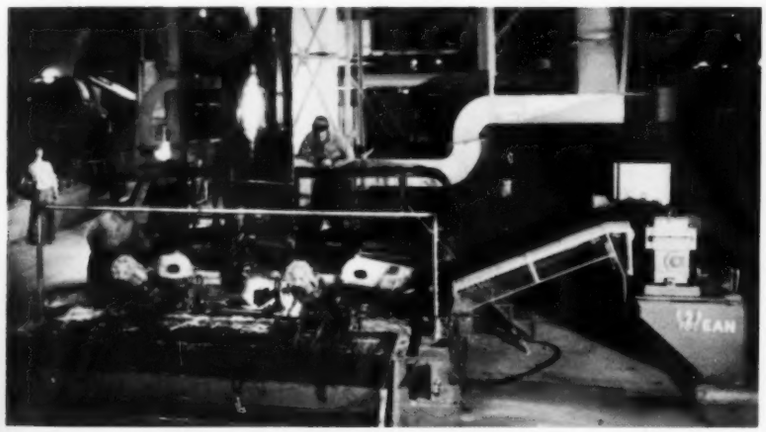


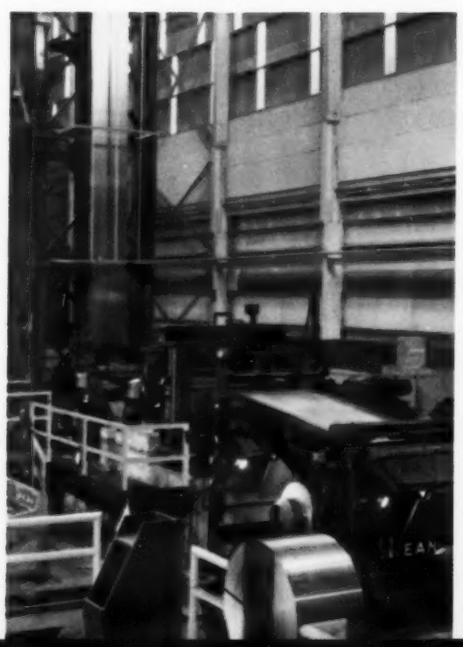






by each Steel Producer





THE steel industry traditionally has been able to solve most of its problems by growth. And the saga of this growth, both in tonnage and versatility of our mills, is an impressive one. Never before has steel been so important to our nation. And with soaring population, a steadily climbing standard of living, and exciting new products on the horizon, the further expansion of the steel industry is assured.

But the next decade poses challenging problems with this promise of growth: increased competition, shifting markets and the changing nature of steel demand are all problems for which each producer must find his own, best answer.

Cost reduction is one area that must be given very close attention. In some cases, expanding production will help "dilute" costs; in others, true reduction of costs by automation of present equipment and technological improvements is the answer.

Modernization will be a prime objective for many firms. Old equipment will be replaced by high speed, high production units which will greatly increase efficiency.

Planned distribution will continue to be a major factor in the development of new facilities. Every expansion program will have to be plotted with regard to market areas and transportation of raw materials and finished products. The Seaway project and the recent development of rail-highway transportation are examples of new opportunities in this area.

Customer service has already reached a remarkable stage of development in metallurgical liaison, but even greater strides are indicated for the future. Steel firms must help the customer get the improved materials he needs, when he needs them, and at a competitive price.

Quality control will be given even greater emphasis than ever before in order to assure customers of uniform quality materials in the competitive days ahead. Closer control will reduce scrap losses in production, too.

New markets will be tapped by some firms as they diversify their output through addition of new finishing facilities. New products, too, will open new markets for steel: vinyl-clad strip and "thin" tin plate, recently emerged from the research laboratory, are typical.

Wean Engineering has dedicated its resources and abilities to one field: the design and construction of sheet, strip and tin plate processing lines for steel producers. In this specialization, we have been privileged to work with all the major steel companies over the 31 years of our history.

2179 Years of Strip Processing Knowledge

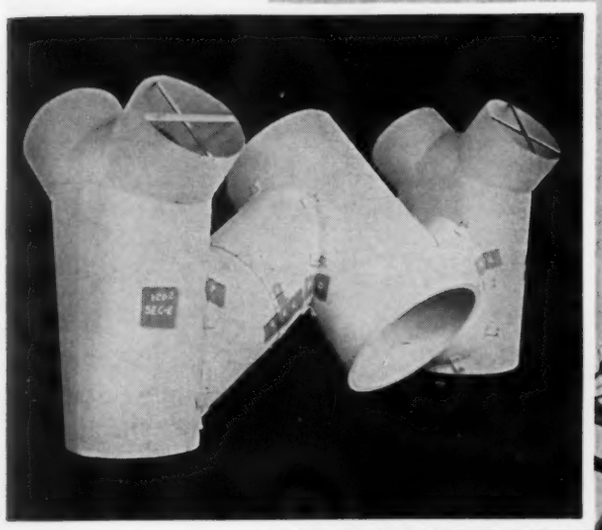
The cumulative experience of Wean's personnel represents a good many lifetimes devoted to one field: continuous strip processing line design and manufacture. The "creative engineering" abilities of our staff have given the steel industry more efficient and productive processing lines for tinning, galvanizing, annealing, pickling, cleaning, coil preparation, shearing and slitting.

Today, as ever, we look forward to a continuation of the working partnership where our experience and capabilities can help the steel industry meet the challenges of the Sixties.

THE WEAN ENGINEERING COMPANY, INC. • WARREN, OHIO

Associate Companies: Wean Manufacturing Company, Warren, Ohio • Wean Equipment Corporation, Cleveland, Ohio
Wean-Damiron, S.A., Paris, France • Wean-Miles, Ltd., London, England • McKay Machine Company, Youngstown, Ohio
Wean Engineering Company of Canada, Ltd., Hamilton, Ontario

Litho in U.S



ENGINEERING . . . FABRICATION . . . AND ERECTION . . . BY *Pollock*

The William B. Pollock Company is the oldest engineer, fabricator and erector of steel work for blast furnaces in the world

Only a few companies in the world can engineer, fabricate and erect the steel work for a complete blast furnace, and The William B. Pollock Company is one of them. Over the years Pollock has erected more blast furnaces than anyone in the world. We're specialists in heavy steel work, fully equipped to engineer and fabricate plate and structural requirements and do heavy machine work on castings and weldments.

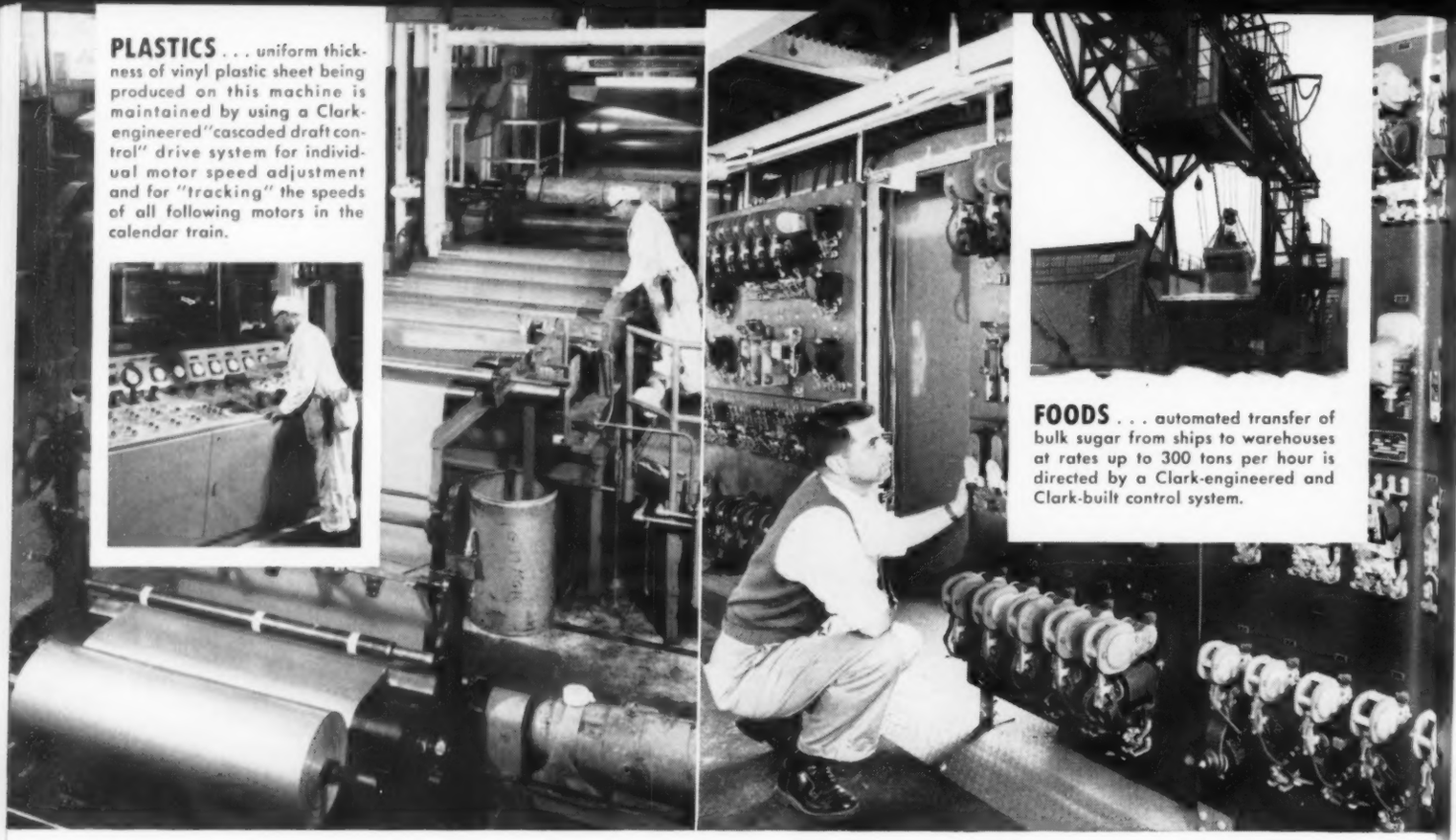
Pollock engineers are at your service. Use them. They'll analyze your needs and suggest the most practical, efficient and economical solutions.

POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO

Associated in Great Britain with Ashmore, Benson, Pease & Co.

ENGINEERS, FABRICATORS AND ERECTORS OF BLAST FURNACE STEEL WORK . . . HOT METAL AND SLAG HANDLING EQUIPMENT FOR . . . BLAST FURNACE, OPEN HEARTH AND ELECTRIC FURNACE PLANTS

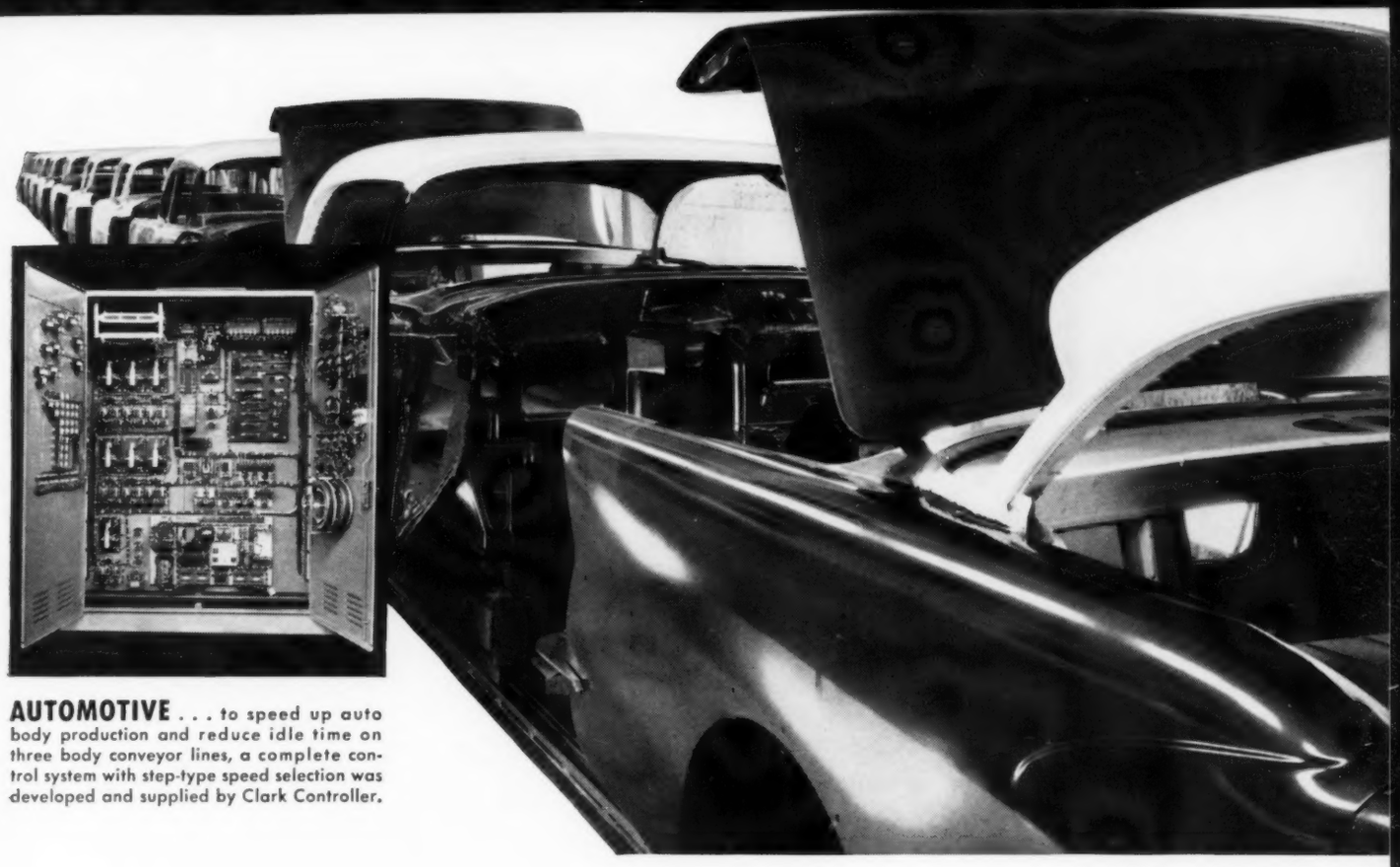


PLASTICS . . . uniform thickness of vinyl plastic sheet being produced on this machine is maintained by using a Clark-engineered "cascaded draft control" drive system for individual motor speed adjustment and for "tracking" the speeds of all following motors in the calendar train.

FOODS . . . automated transfer of bulk sugar from ships to warehouses at rates up to 300 tons per hour is directed by a Clark-engineered and Clark-built control system.

How to get the most from

METALS . . . the precise speed and tension regulation required by this versatile rolling mill is provided by a control and drive system completely coordinated by Clark engineers.



AUTOMOTIVE . . . to speed up auto body production and reduce idle time on three body conveyor lines, a complete control system with step-type speed selection was developed and supplied by Clark Controller.

your machines and processes

Automatic control is the most vital element in today's automated processes, systems and machines.

Clark engineers are specialists in automatic controls, and Clark's control equipment—relays, contactors, push buttons, control centers, etc.—is designed with a thorough knowledge of specific industry requirements.

Clark is therefore ideally qualified to furnish complete coordinated control and drive systems.

Perhaps this great combination of product and experience can help you directly. It makes no difference what industry or type of production machinery or process. More and more automation-minded manufacturers everywhere are turning to Clark for completely coordinated control engineering service and equipment.

From concept to start-up, Clark engineers work as partners with engineering and manufacturing personnel, consulting engineers, contractors, and equipment manufacturers. We welcome the opportunity to show you how they can work for your particular advantage. For more information, contact your nearest Clark Controller sales office. Or, write direct.

60 A1

The
CLARK CONTROLLER
Company

"Everything Under Control"

Main Plant: *Cleveland 10* • **Western Plant:** *Los Angeles 58*
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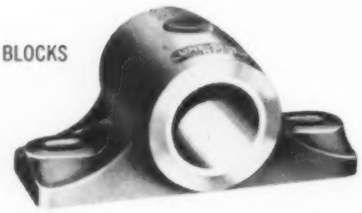
LINK-BELT'S babbitted and bronze bearing line offers

all these designs

all these features

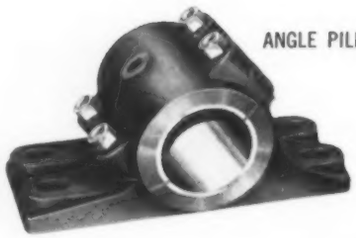
SOLID PILLOW BLOCKS



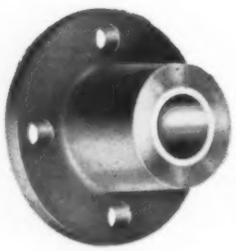
SPLIT PILLOW BLOCKS

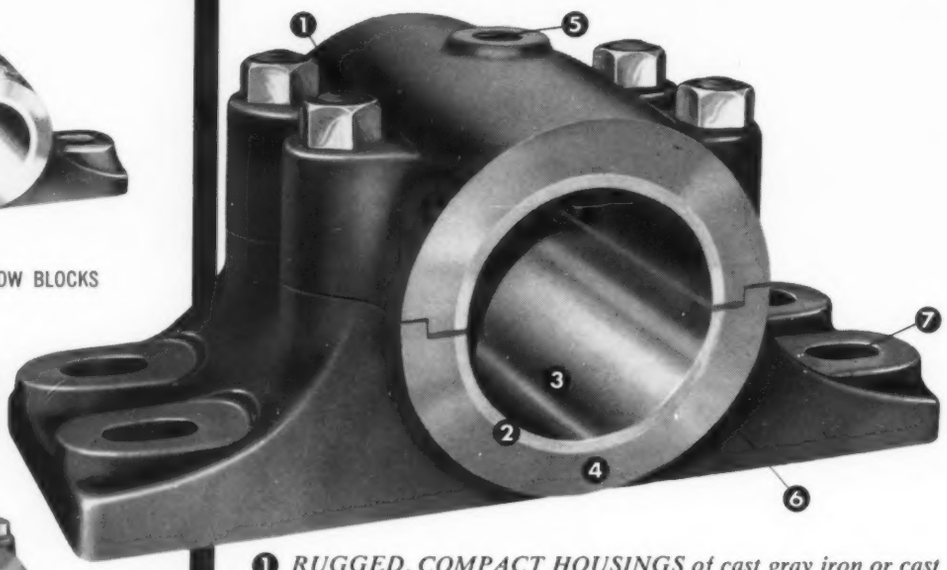
GIBBED PILLOW BLOCKS

ANGLE PILLOW BLOCKS



FLANGED BLOCKS





❶ *RUGGED, COMPACT HOUSINGS of cast gray iron or cast steel,* solid or split design, provide exceptional strength where needed, without excess size or weight. ❷ *STURDY BEARINGS* of thick, heavy-duty babbitt or high-quality bronze are anchored in housing. ❸ *PRECISION MACHINED BORES* provide correct running clearance between shaft and bearing metal for load carrying oil or grease film. ❹ *MACHINE FINISHED ENDS* allow flush mounting of sprockets, pulleys, wheels and collars. ❺ *RELIABLE LUBRICATION*—Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire bearing surface. ❻ *MACHINED BASES* assure firm seating on supports. ❼ *SLOTTED BOLT HOLES* permit easy adjustment for shaft alignment.

OFF-THE-SHELF DELIVERY is offered by Link-Belt on more than 15 types and over 300 sizes of babbitted and bronze bearing pillow blocks in cast iron or cast steel . . . for commercial shafting up to 12" diameter. Also immediate delivery on flanged blocks and takeups in all popular sizes. Book 2707 contains helpful information on the selection and application of these bearings. For your copy, contact your nearest Link-Belt office or authorized stock-carrying distributor. Look under BEARINGS in the yellow pages of your phone book.

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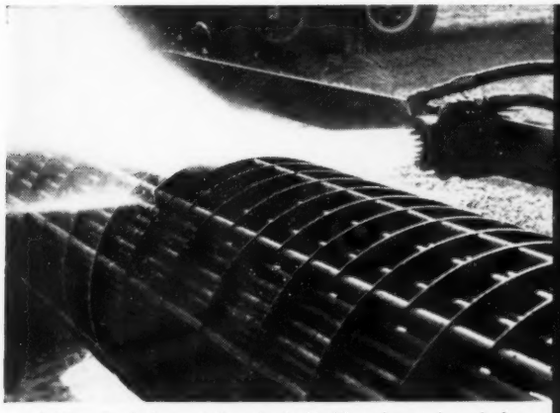
LINK-BELT

BABBITTED AND BRONZE BEARINGS

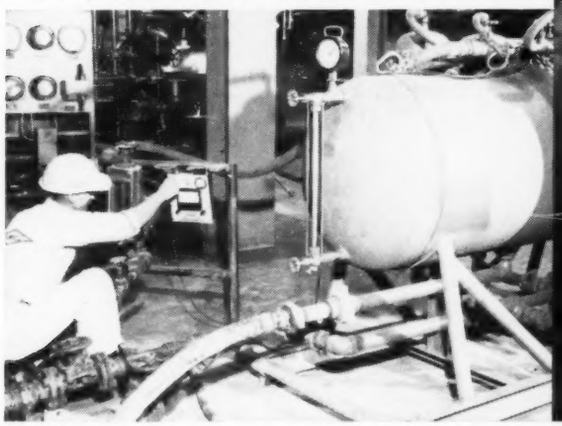
15,372

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sidney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

A new mark for a nation-wide cleaning service . . . DOW



Jetting tool cleans tubes fouled with coke and asphalt.



New mobile foam-cleaning equipment cuts cleaning costs.

Cleaning missile lines and components requires tolerances as close as 150 microns.

DOW INDUSTRIAL SERVICE

Industrial Cleaning. Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

Product Sales and Service. The sale of specialized chemical products, scientifically formulated to be of use in specific industrial processes and to give the necessary technical service in their use, is the job of Product Sales and Service. Purifloc* N17 is an outstanding new flocculant cleared by USPHS for use in potable water.

Laboratory Service. Because of the rapid development of chemical products for the municipal and industrial waste and water treatment areas, Dow Industrial Service will take on the service-selling of those products. Also, a consulting laboratory service for municipal and industrial waste and water treatment is provided.

You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.

*TRADEMARK

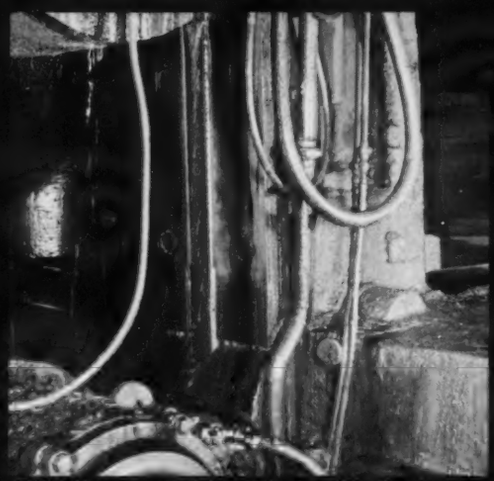
DOW INDUSTRIAL SERVICE DOW *Division of THE DOW CHEMICAL COMPANY*

you can depend on

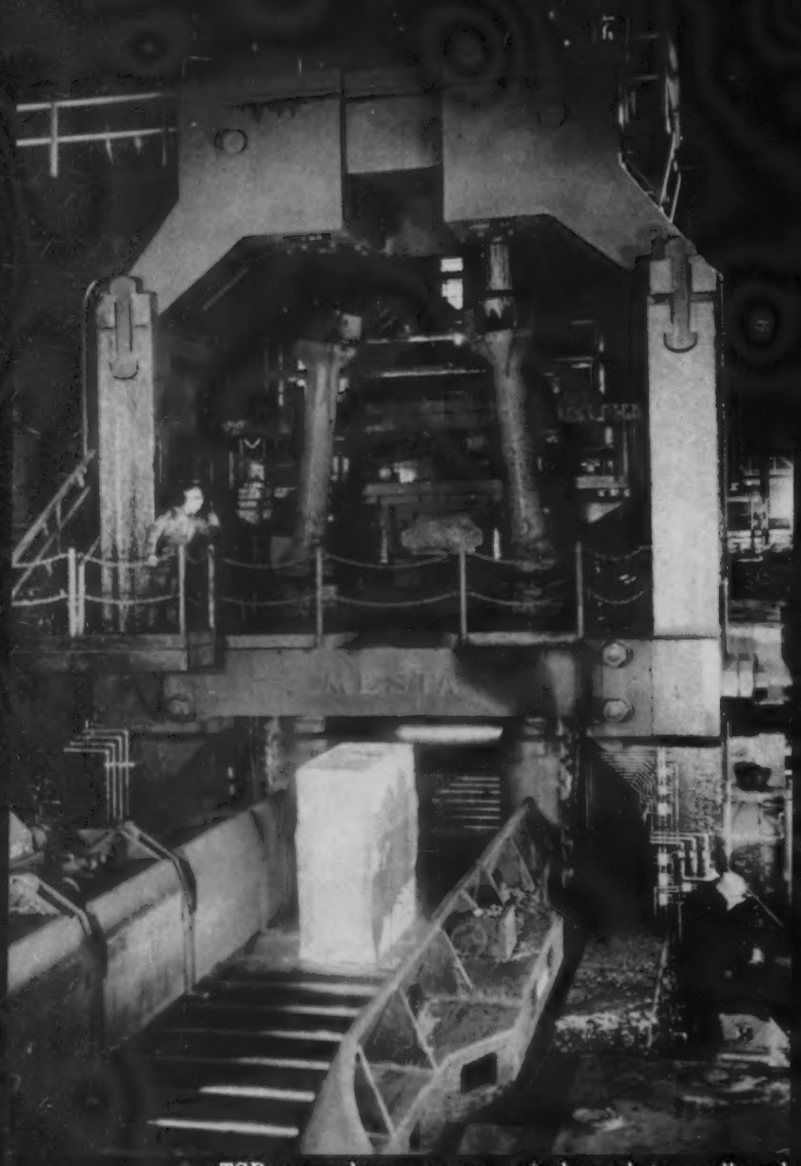
TSP hardened products

GREAT LAKES STEEL C

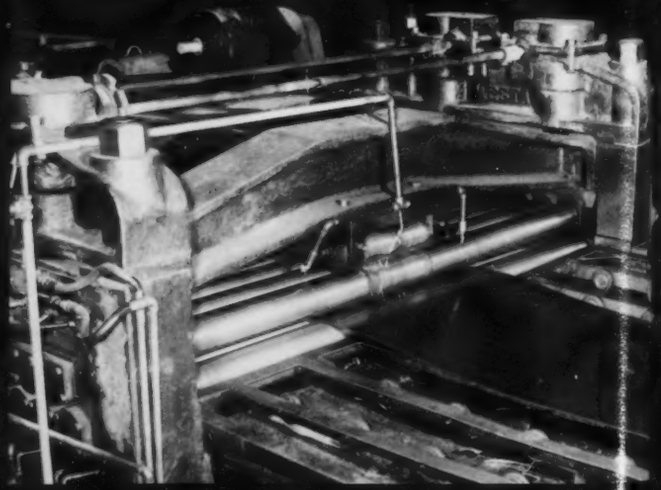
TSP helical gears on edging mill shows little wear after several years service.



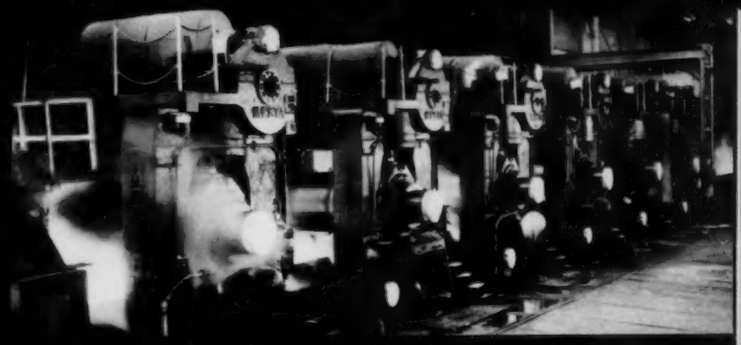
TSP liners on blooming mills last for years without replacement.



TSP screwdown screws, window plates, roll and approach table bevel gears on slabbing mill.



TSP leveller rolls deliver extra long life.



TSP edger gearing on hot strip mills.

L CORPORATION does!

With TSP axles, maintenance costs from axle breakage, have been greatly reduced.

TSP track wheels, spur and herringbone gears, sheave wheels on ore bridges.

At the Great Lakes Steel Corporation, Detroit, a Division of National Steel Corporation, "Tool Steel Process" hardened products are delivering the dependable, long wearing service that means reductions in maintenance and replacement costs. Great Lakes Steel is a prime user of TSP screw-down screws and nuts, gears and pinions, track and sheave wheels, leveller, pinch, back-up and coiler carrying rolls, arbors, shafts and axles, sprockets and mill pinions.

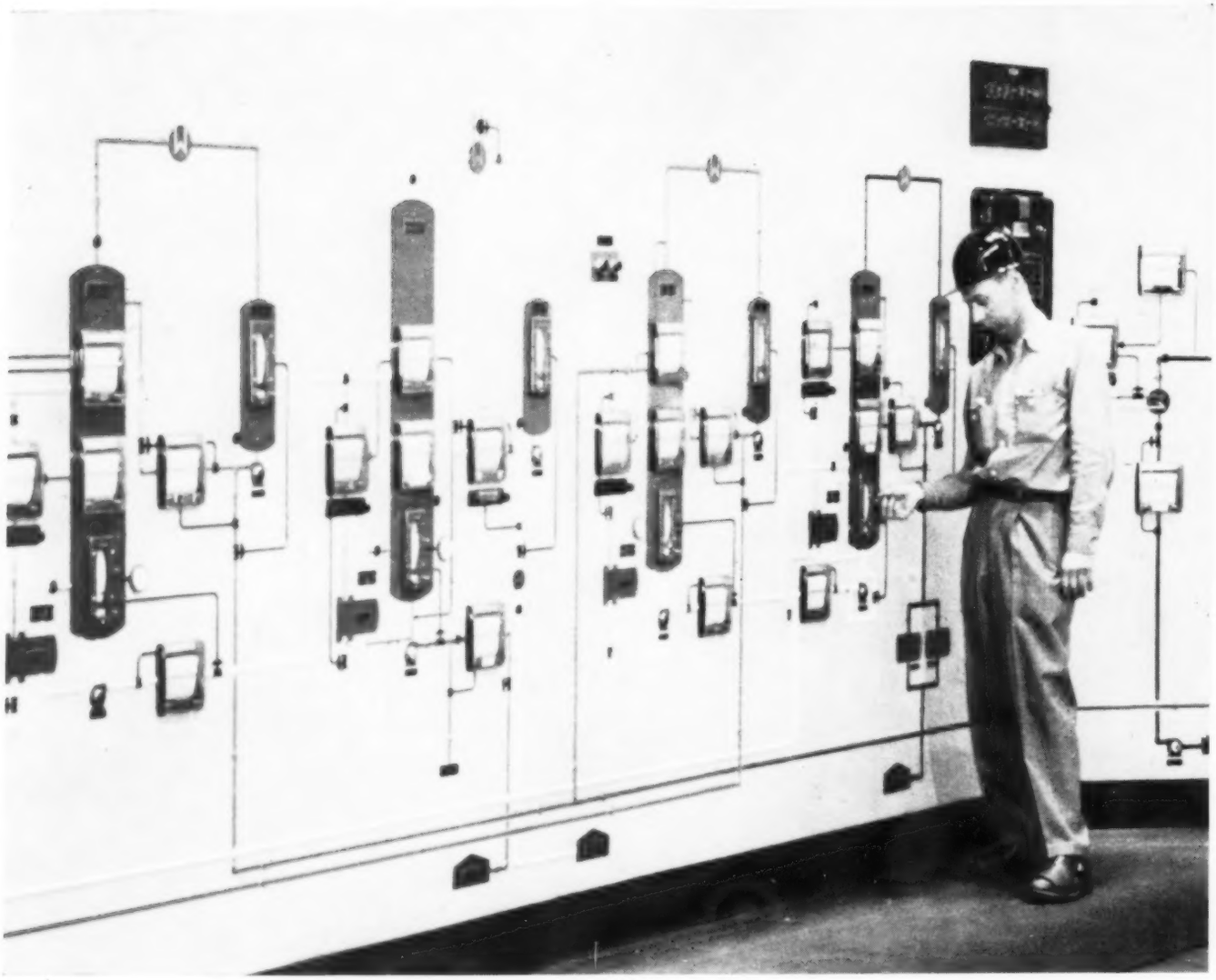
All TSP products are hardened by our special process. The file hard surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive a written guarantee that TSP products will wear longer in the same service than any other competitive product.

Write today—see how TSP products can save money for you.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO

The standard of quality since 1909 for gears, pinions, rolls, wheels and other hardened products.

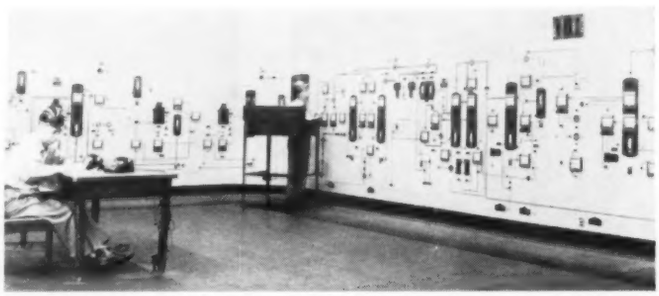
Printed in U. S. A.—AD 1047



Foxboro Consotrols* "easy on maintenance" at U. S. Steel's Gary Works

Foxboro Consotrol Instruments have been in service 5 years at U. S. Steel's Gary Works, yet only a few have ever needed calibration. In fact, Gary Works reports that many of the Foxboro M/58 Controllers have never even had their covers off.

Low maintenance is just part of the Foxboro Consotrol story. Sustained high accuracy, precise repeatability, a full range of control functions — you get them all when you specify Consotrol instrumentation. Get full details in Bulletin 13-18, or call your nearby Foxboro field engineer. **The Foxboro Company, 589 Neponset Ave., Foxboro, Mass.**

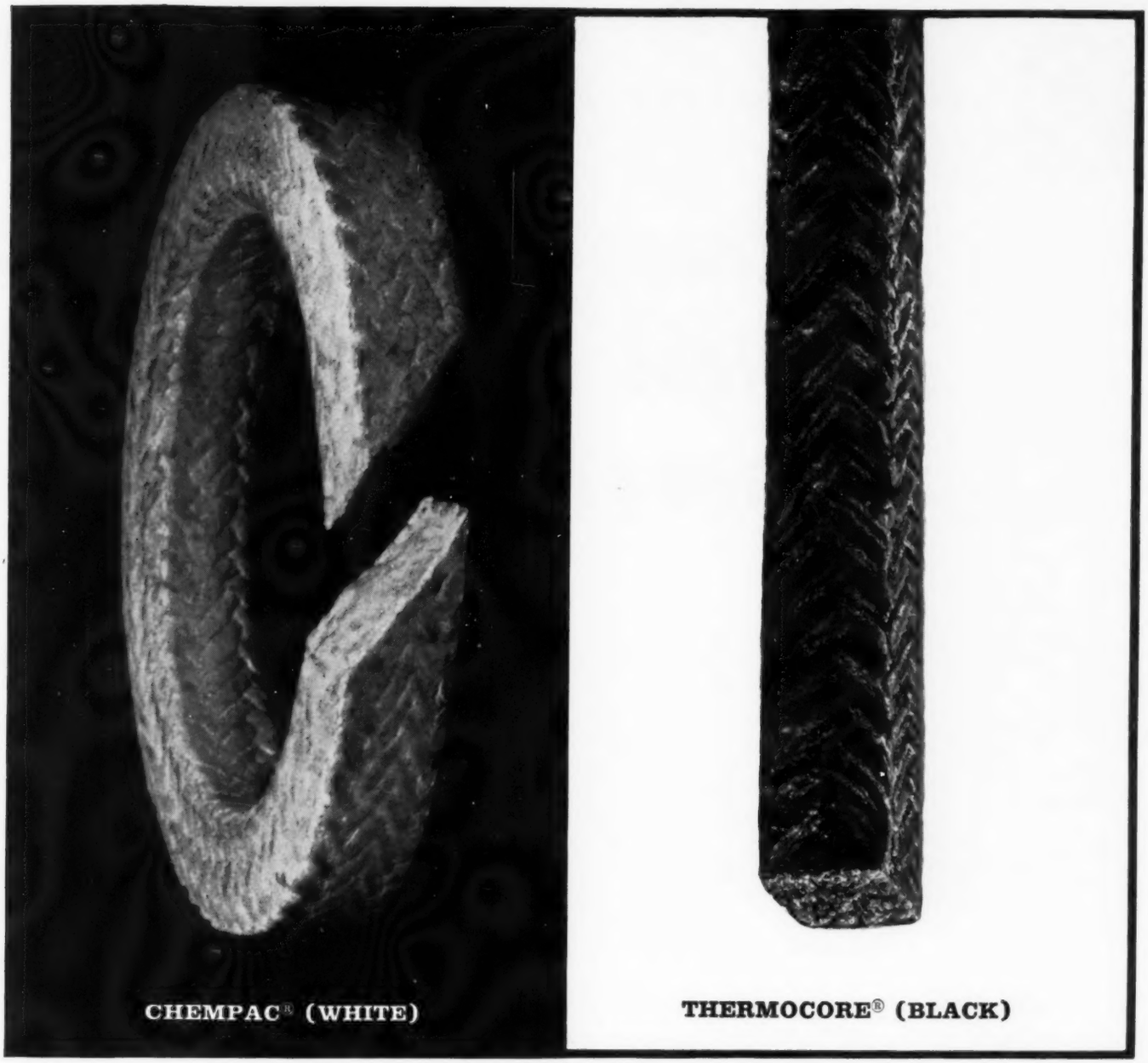


83 foot graphic control panel for Gary Works Light Tar Distillation Plant was built by Foxboro in 1954. 250 Consotrol instruments record and control all temperature, pressure, flow and liquid level variables. *Consulting Engineers:* United Engineers and Constructors, Inc., Philadelphia.

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.



CHEMPAC® (WHITE)

THERMOCORE® (BLACK)

Now—just two J-M styles will handle 9 out of 10 mechanical packing problems!

LET VERSATILE "BLACK" OR "WHITE" HELP YOU REDUCE PACKINGS INVENTORY

Of Johns-Manville's many packing styles, two stand out as "all-purpose" packings. One is for pumps, the other for valves. These two packings not only do an outstanding sealing job . . . they also simplify your packings inventory investment to a minimum.

In 9 out of 10 cases, CHEMPAC and THERMOCORE will handle any pump or valve job in your plant!

CHEMPAC (white) combines the excellent sealing and heat-resistant qualities of asbestos . . . with Teflon's immunity to almost all chemical and solvent action. Chempac Style 2009 will give outstanding service on pumps, expansion joints and agitators.

THERMOCORE (black) consists of asbestos yarns, reinforced with Inconel wire . . . braided over a plastic core of graphite and 100% white asbestos. It remains stable even in valves where line temperatures run as high as 1200 F . . . adapts readily to eccentric motion. Thermocore Style 397 is recommended as the "universal" valve packing.

Johns-Manville produces the industry's most complete range of packing styles. These are described in a new 64-page Mechanical Packings book—the most complete of its kind. In its handy pages, you will find answers to the correct selection of packings best suited to each particular requirement.

For full information on "WHITE" and "BLACK," see your J-M Distributor . . . or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ont.

JOHNS-MANVILLE JM PRODUCTS

NEW SLANTS ON HEAT PROCESSING FROM SELAS

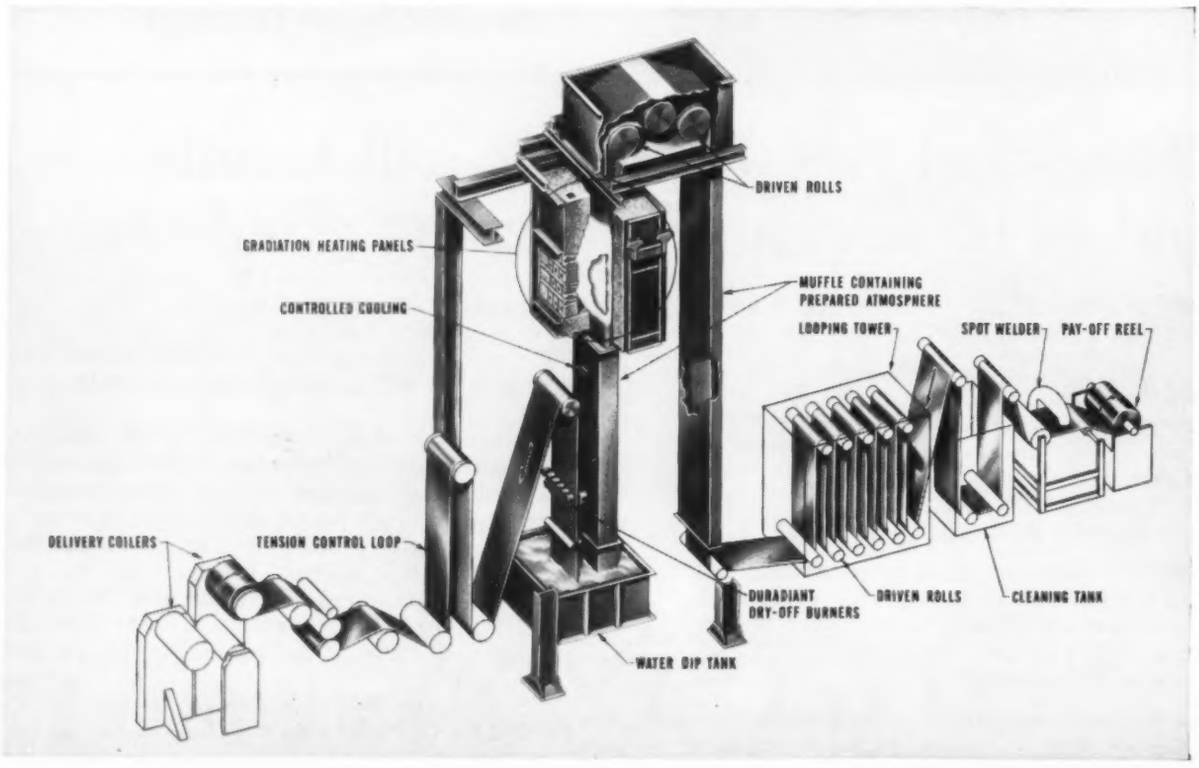
are these your objectives stainless strip continuous furnaces?

- **Top strip quality in terms of surface condition, microstructure, mechanical properties and flatness**
- **Uniform heating, with long muffle life and ease of muffle replacement**
- **Compact design to save floor space**

These were the main objectives of Somers Brass Co., Waterbury, Conn. — achieved when they selected a new continuous annealing furnace for stainless steel strip and other refractory alloys, designed and built by Selas engineers. It has been in production since July, 1958.

The furnace was designed for maximum strip speed of 50 fpm. It can handle strip 0.001 to 0.020 in. thick and 8 to 26 in. wide.

Up and over vertical design saves valuable floor space, provides controlled atmosphere protection.



in selecting annealing

The muffle (6 x 36 in. in cross-section) is arranged in an inverted U. The vertical lengths are 5½ ft. apart and the horizontal cross-over is about 27 ft. above floor level. Compared to horizontal muffles, this arrangement *requires less muffle material, extends muffle life, provides uniform strip temperatures* and *improved atmosphere purging.* The entire strip line length is only 50 ft. Heating and cooling operations require only 10 ft. of floor space.

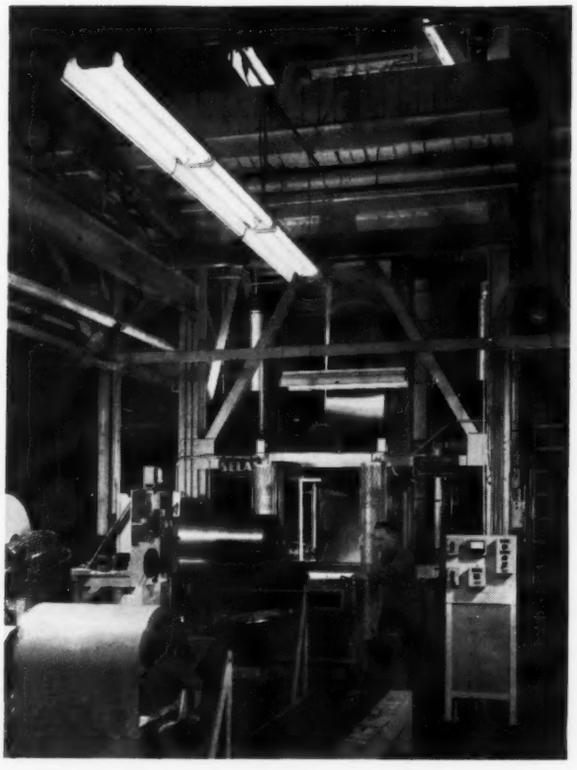
Selas Gradiation® method of uniform muffle heating in the two opposing burner panels, with burners patterned in four horizontal rows, assures uniform temperature across the strip width. The strip is equidistant from the radiating muffle-wall over its entire width.

Burners are fired by a gas-air mixture from a special Selas Combustion Controller installation. This premixes to a desired ratio and pressure, feeds through a single pipe system to the burners.

Somers' customers report improved die and tool life in deep-drawing operations with the stainless strip from this furnace—attributed to *uniformity of annealing,* and *improved surface completely devoid of surface oxide or other imperfection.*

Want to know more about this new Selas method of continuous stainless steel strip annealing—and the advantages of Selas Gradiation heating as applied to your processing problems? Just write to Mr. R. E. Buckholdt, Manager, Furnace Division.

SELAS CORPORATION OF AMERICA
49 Dreshertown Road, Dresher, Pa.



Total strip line length only 50 ft. Simple threading device, built into muffle system, permits rethreading in minutes, without loss of atmosphere, in event of tear-off of strip

SELAS

HEAT AND FLUID PROCESSING ENGINEERS

DEVELOPMENT
•
DESIGN
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CONSTRUCTION

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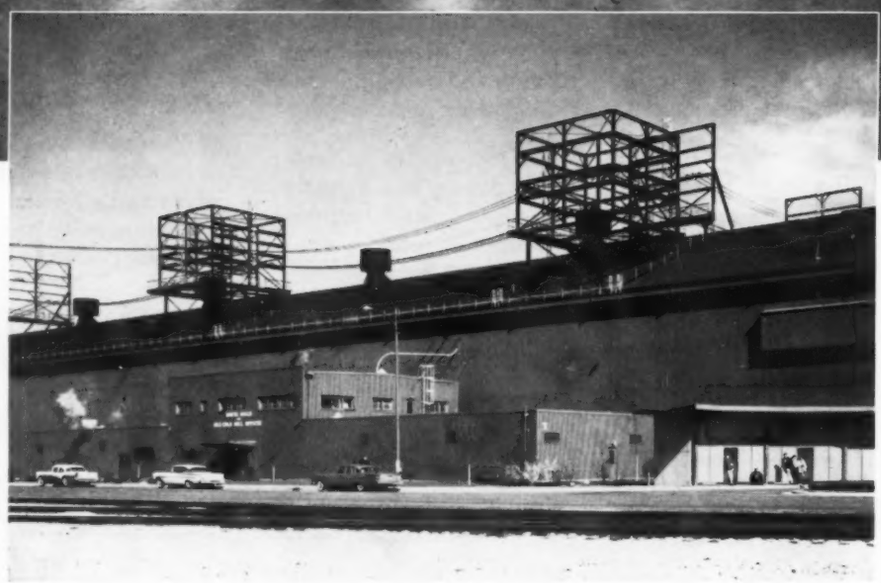
GRADIATION is a registered trade name of Selas Corporation of America

Inland Steel Company, Indiana Harbor Works. View shows Normalizing Line in Inland's new No. 3 Cold Mill where Austin's work included foundations, service tunnels, control house and erection of the complete line, including piping, electrical work and installation of equipment and furnaces.



Superintendents Office and locker room at Inland's new No. 3 Cold Mill. Design and construction by Austin.

Republic Steel Research Center, Independence, (Cleveland) Ohio, on 106 acre site, contains 100,000 sq. ft. devoted to research and process and product development. Although much of Republic's research has been centralized at this location, the company will continue to utilize laboratories at its various plants for supplemental research, as well as its separate Electromechanical Research Center in Cleveland. Site selection, design and construction under the Austin Method.

THE AUSTIN METHOD

THE AUSTIN COMPANY • ENGINEERS AND BUILDERS

MINING AND METALS DIVISION

CLEVELAND • NEW YORK • DETROIT • CHICAGO • HOUSTON • SEATTLE • LOS ANGELES • MONTREAL
GATESHEAD-ON-TYNE, ENGLAND • PARIS • SIDNEY • MEXICO CITY • SAO PAULO • BUENOS AIRES

Providing New Mill Facilities with Speed and Economy

Austin design and construction services offer speed and economy in providing a wide variety of steel plant facilities and auxiliary buildings for new plants or the modernization of existing facilities.

Projects by Austin have included such production units as normalizing lines, electrolytic tinning and galvanizing lines, soaking pits, stripper buildings, acetylene generating plants, gas mixing and oxygen metering facilities including all mechanical piping, as well as heavy-duty mill buildings.

Austin has served a number of leading steel companies over a period of many years in the design and construction of mining projects, ore beneficiation, pelletizing and steel production facilities.

Austin services for the Steel Industry include —

- Site Selection and Investigations
- Site Layout Studies
- Engineering Reports
- Materials Handling Studies
- Preliminary Cost Estimates
- Preparation of Working Drawings
- Purchasing and Expediting
- Construction with Austin Forces
- Foundations for Buildings and Equipment
- Installation of Process Equipment
- Mechanical Piping and Electric Power Wiring
- Structural Steel can be provided by Austin's Steel Fabrication Division

Ask for a new folder which illustrates and describes Austin Services in the Steel Industry. Consultations arranged on request.

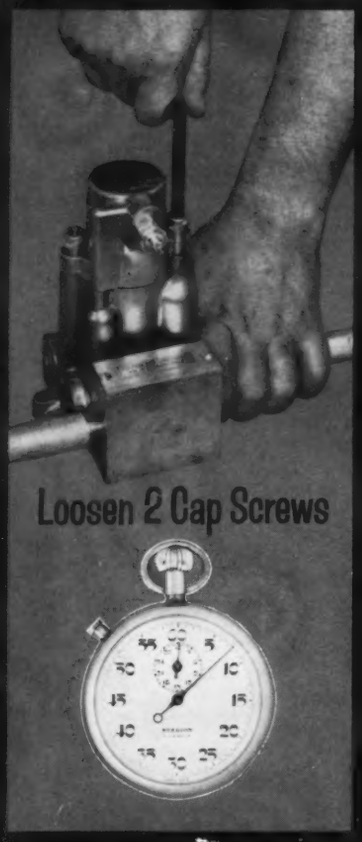
Aerial view of Allegheny Ludlum's new plant at Bagdad, Pa., opposite their West Leechburg Works. The new mill buildings house a normalizing line and other steel treatment operations, a switchgear house, office and locker facilities, as shown at left. Design and construction by Austin, whose Steel Fabrication Division furnished the all-welded structural steel.

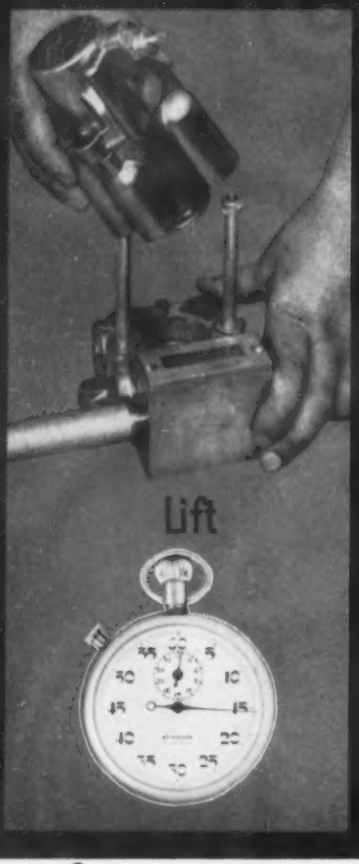
ONE MAN ONE TRADE ONE TOOL

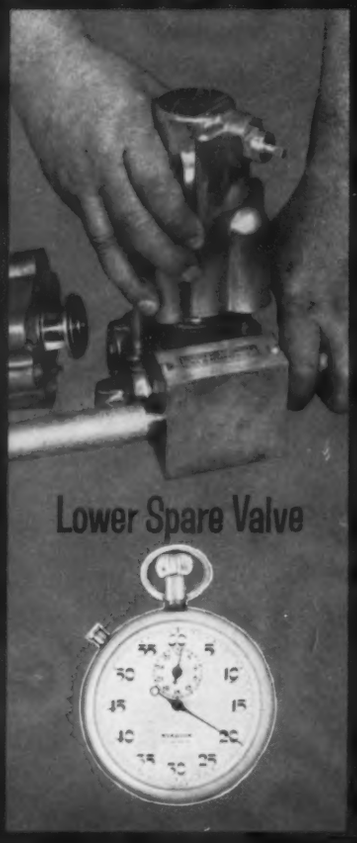
...your production line back in operation in

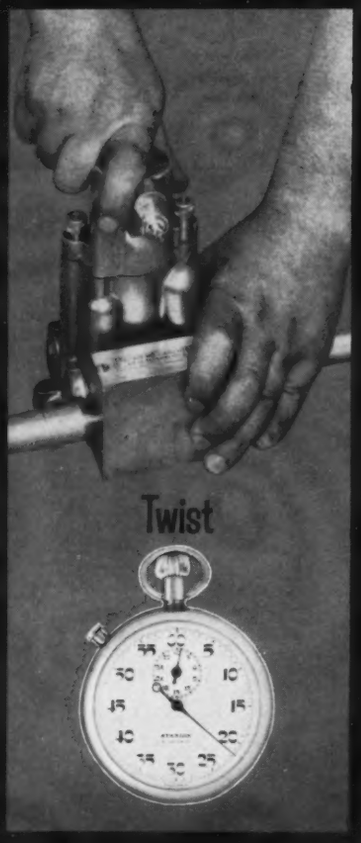
30 SECONDS

(if it's a Hunt PDQ Air Control Valve)









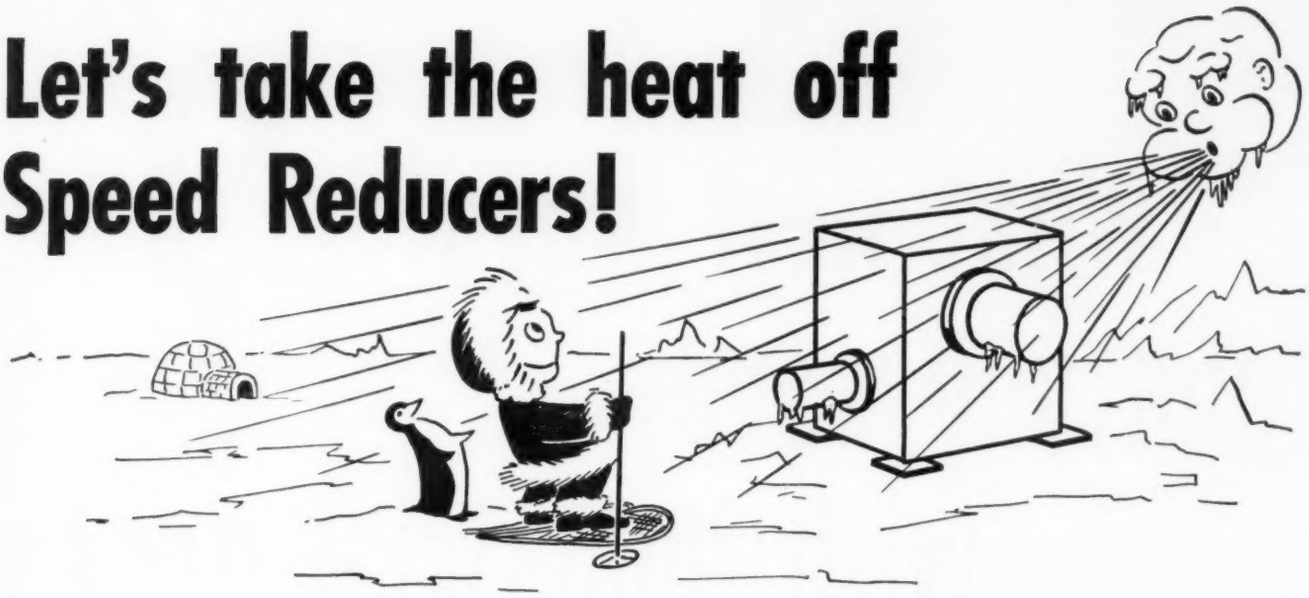
☑ accessibility ☑ simplicity ☑ speed and capacity ☑ price and quality

No bulletin can do it justice... have the Hunt man call. Write to:

HUNT VALVE COMPANY DIVISION OF IBEC SALEM, OHIO

HUNT V H C *Quick-As-Wink* AIR & HYDRAULIC CONTROL VALVES

Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

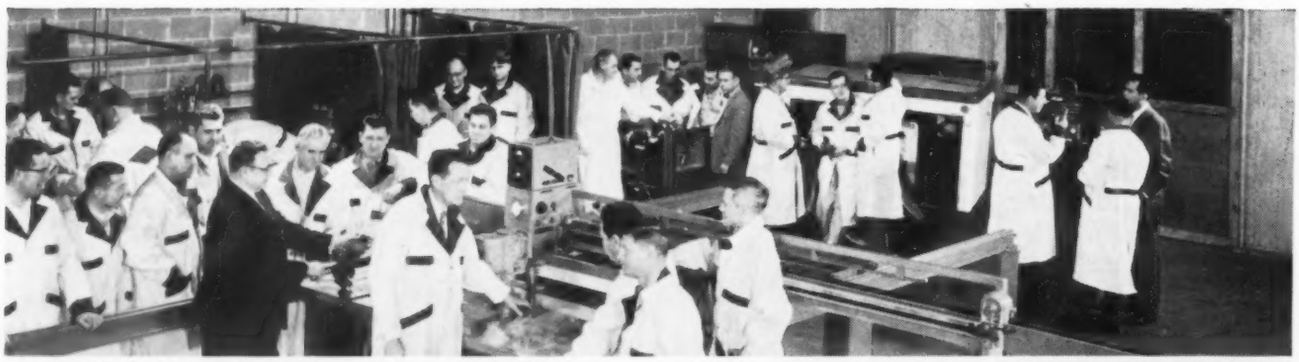
In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

What new ways can you save with industrial gases ?



ask your Liquid Carbonic sales engineer...

Visit booth no. 569, Iron and Steel Exposition

So many are the ways to use compressed gases . . . so rapidly do new techniques appear . . . how can you keep up with them all?

That's our job—a part of Liquid Carbonic service.

Through a continuing program of "What's New" seminars, Liquid Carbonic sales engineers learn all the recent developments at first hand: new applications of gaseous and liquid oxygen, liquid nitrogen, hydrogen, acetylene, CO_2, argon. Cost-cutting ideas for steelmaking, casting, cutting, fabricating, welding . . . all learned from the practical standpoint—all "learned by doing."

Discover the latest applications of industrial gases, using dynamic Liquidweld apparatus and precision Messer cutting machines.

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GENERAL DYNAMICS CORPORATION / Liquid Carbonic Division

135 South LaSalle Street, Chicago 3, Illinois

A MAJOR PRODUCER OF COMPRESSED GASES: OXYGEN, ACETYLENE, NITROGEN, HYDROGEN, ARGON, CARBON DIOXIDE, NITROUS OXIDE, HELIUM AND VARIOUS GAS MIXTURES

Equipment News...

HOPPER CAR THAWING

△ Thawing frozen hopper cars at United States Steel Corp.'s Youngstown District Works is now faster, simpler and less costly as a result of installation of a new type of gas-operated, infrared thawing equipment.

An engineered "package," the new equipment includes side panels, overhead heaters and undercar units operating in concert. The amount of heat supplied to different areas is tailored to the nature of the thawing problem in each area.

The equipment has been installed at Sintering Plant No. 2 of the Youngstown Works. It can be used, without adjustment, to thaw any number of materials, including coal, coke, anthracite, dolomite, limestone and sand.

The system, manufactured and installed by Hauck Manufacturing Co., replaces a torching method previously used.

Faster thawing is now possible both because of the special qualities of infrared heating and the engineered concept that lies behind the thawing equipment.

Infrared rays travel through the air without becoming heat until they strike the object to be thawed. In other words, heat is neither lost en route nor diverted to a heating job other than the one for which it is intended.

To take maximum advantage of this "on target" characteristic of infrared heating, Hauck worked out an arrangement of thawing units to avoid over or underheating.

Since hopper car pockets and slope sheets constitute the toughest thawing problem, the undercar, track-based units are designed to throw out approximately four million Btu per hour. Side panels throw out some two million Btu while the overhead units, designed to remove a top crust of frozen material, can do their job with only 300,000 Btu.

Substantial savings in manpower are possible with this method. The units are already properly placed and need not be positioned by operators, as is the case with torching. One man can operate the Hauck package. Since all controls are located behind the equipment, he can operate it with maximum safety from a protected position.

In addition to operational savings, the infrared system has made possible savings in demurrage and damage to rolling stock. Under the new and faster system, cars do not remain in the thawing station as long, and hence demurrage costs are lower.

Damage to rolling stock during an unloading operation is usually the responsibility of the company doing the unloading. Under the torching system, damage to hopper cars could be considerable. Infrared thawing, which does not damage the cars, has eliminated this problem entirely.

X-RAY GAGE

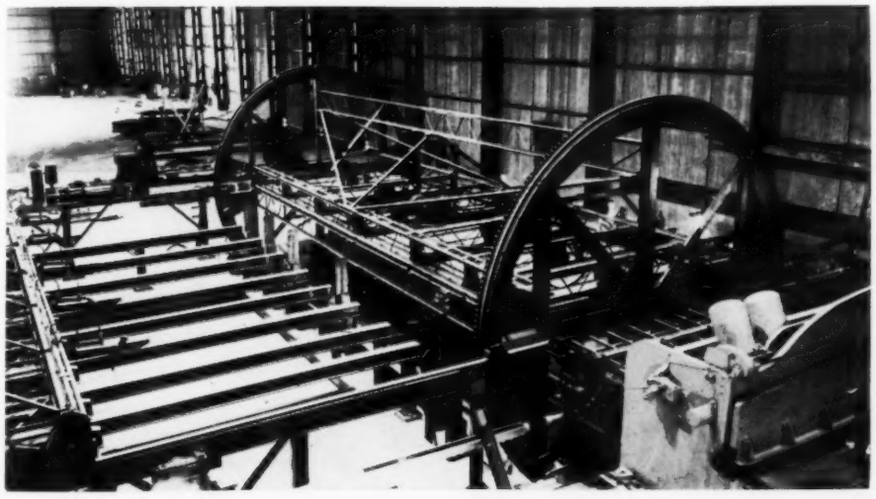
△ The Colorado Fuel & Iron Corp. is using an x-ray pipe wall gage at its Pueblo, Colo., plant to insure precise cropping of end sections of its seamless pipe which fall below job-specified thickness and must be trimmed off.

Part of the finishing operation after the manufactured pipe undergoes straightening, the cropping may involve from a few inches to as much as several feet, where ends are ragged or out of tolerance, in order to meet the rigid specifications of the oil and gas industry. If wall measurements were blind or inexact, too little pipe might be trimmed, necessitating recutting, or an excess might be cropped, with resultant waste of product.

The pipe wall gage, an XactRAY unit manufactured by Daystrom, Inc., Weston Instruments Division,

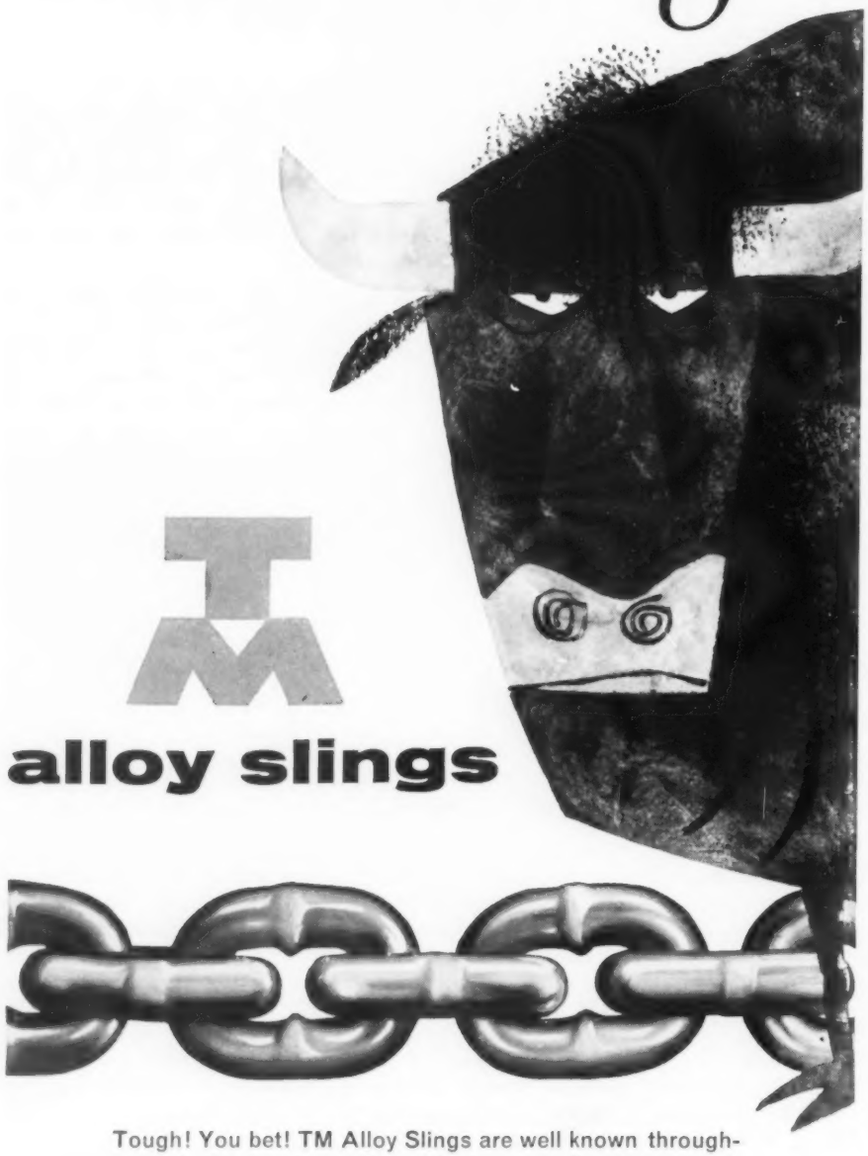
AUTOMATIC WIRE FABRIC WELDER IN OPERATION

This huge 191-ft long automatic wire fabric welding machine, delivered recently to Keystone Steel & Wire Co., by National Electric Welding Machines Co., is capable of producing wire mesh at the rate of 60 tons a day, in widths and patterns for a number of applications, ranging from light fencing to heavy duty highway mats. The unit will turn out mesh up to 17 ft wide. Quick changeover adjustments for wire diameter and spacing are a feature of the machine. Its versatility is such that wire spacing can be controlled in patterns from 2 by 2-in. to 6 or 12 in. The unit automatically coils rolls of lighter fabric, or when heavy mats are being produced automatically slits, stacks and transfers the mats for bundling. The welder joins wire from ⅛ to ½ in. diameter. It employs 80 electrodes for the work, the power being supplied by 40 transformers, each of 40 kva rating, linked in series.



VALUED FOR

Brute Strength



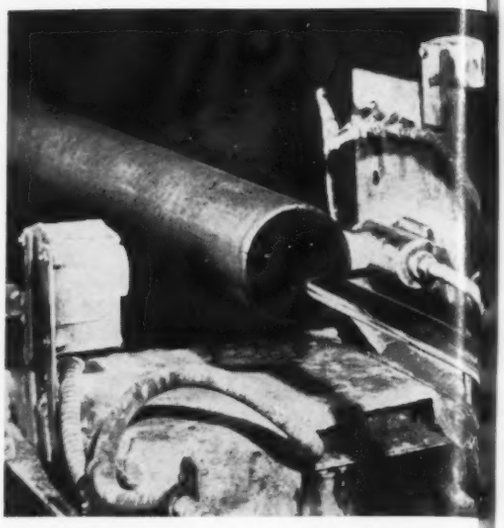
TM alloy slings

Tough! You bet! TM Alloy Slings are well known throughout industry for plenty of muscle, low overall costs and that extra measure of safety. Taylor's safe, sure-grip Tayco Hooks and up-to-the-minute, *scientific*, quality control contribute to the brute strength of TM Alloy Slings. Factory-made to your specifications. Available nationally through industrial distributors, steel warehouses and hardware wholesalers. Write for Bulletin 14A.

Taylor Made CHAIN SINCE 1873

Prompt repairs on alloy slings in both plants.

S. G. TAYLOR CHAIN CO., Inc.
Plants: Hammond, Indiana
3505 Smallman St., Pittsburgh, Pa.



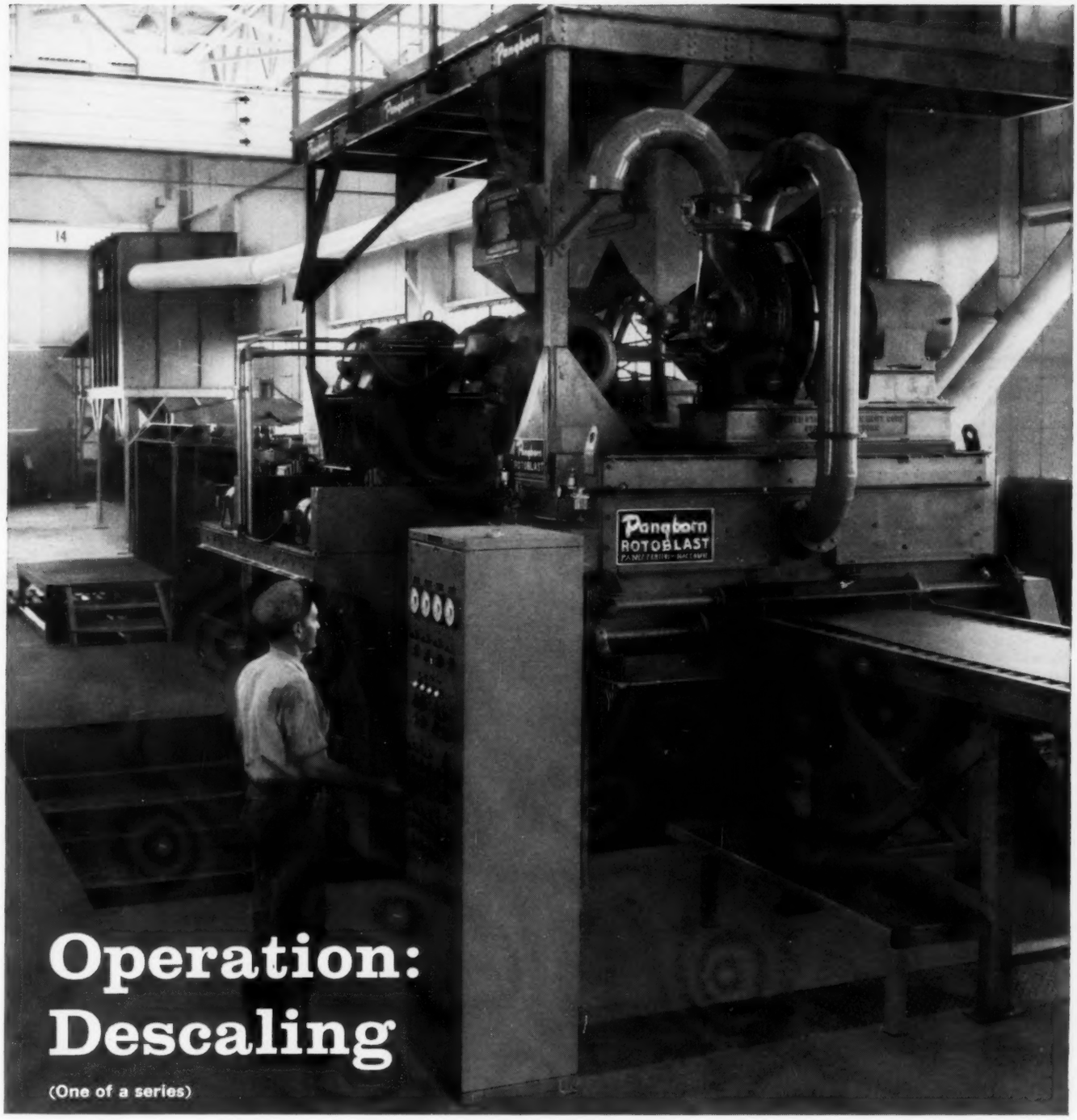
X-ray pickup probe is shown entering end of revolving pipe. To right and above pipe end is paint spray nozzle which marks below-tolerance section for precise cropping at the cutting machine. The gage eliminates the job of repeated cutting and measuring of pipe ends to insure that pipes meet specifications.

is an electronic micrometer, operating without contact, which accurately gages the pipe wall to within one per cent of thickness. Simultaneously, the gage causes the under-gage areas of the pipe to be marked with a paint spray to indicate the proper crop point. Measuring and marking is at the rate of four lengths per minute.

The mobile section of the x-ray equipment is mounted on a hydraulically operated, manually controlled carriage and consists of an x-ray source unit and a probe tube pickup.

Pipe to be gaged is dropped onto motorized rolls which are positioned directly in front of the x-ray carriage. The rolls rotate the pipe as the gage carriage moves forward. A photoelectric unit—interrupted by the pipe—activates the x-ray equipment as the probe approaches. After the probe enters the pipe, a pencil beam of x-ray energy of fixed intensity is tranmitted through a single wall from the source unit and the unabsorbed energy is detected by the pickup probe.

Since the pipe is rotating on the rolls, the gage's inspection follows a spiral path, with the pitch of the spiral determined by the rate of travel of the carriage and the speed of rotation of the pipe. Variations in the amount of transmitted energy



Operation: Descaling

(One of a series)

Rotoblast Descaling pays off 4 ways!

The Van Huffel Tube Co., Warren, Ohio, produces rolled shapes and welded tubing—some 2,000 shapes altogether. To descale strip coils before fabrication, Van Huffel uses a Pangborn Rotoblast Descaling Machine. And gains four ways! Now, by purchasing unpickled steel, the company gets better delivery. This improved delivery schedule permits a reduction in storage required for "slow delivery" emergencies. Also Rotoblast Descaling provides better paint adhesion on the finished surface. And descaling 4,000 to 5,000 tons a month, the Pangborn Rotoblast Descaling Machine cuts total descaling costs substantially.

How many ways can Rotoblast Descaling pay off for you? Talk to your Pangborn man or write today to PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning, Vibratory, Dust Control Equipment—Rotoblast® Steel Shot and Grit.℠*

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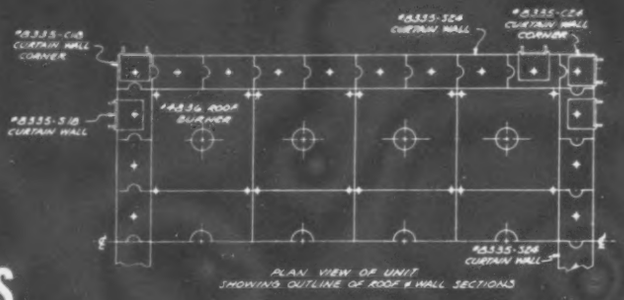
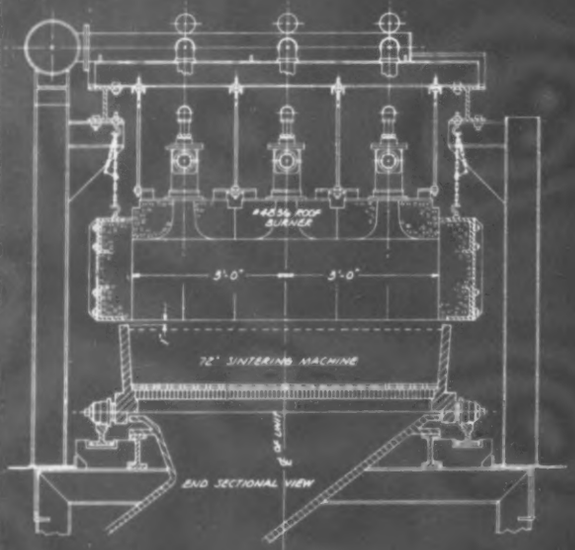
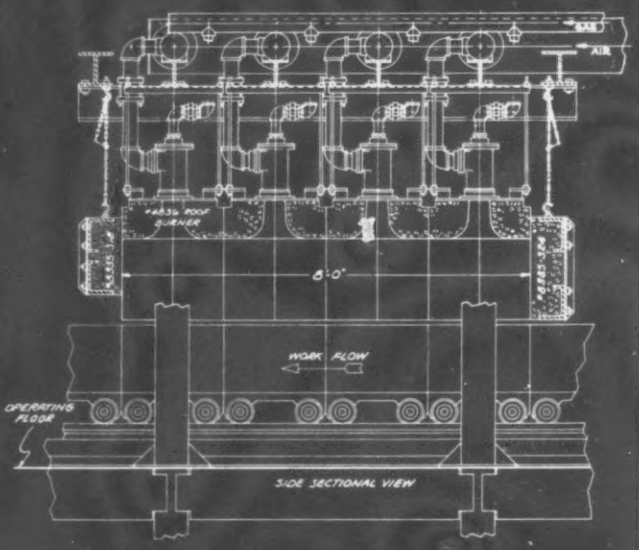
Build your Sintering Ignition Furnace with NORTH AMERICAN Roof Burners & Curtain Walls


#8335-CCA CURTAIN WALL CORNER
#8335-324 CURTAIN WALL
#8335-CCA CURTAIN WALL CORNER
#8335-318 CURTAIN WALL
#4834 ROOF BURNER
#8335-326 CURTAIN WALL
PLAN VIEW OF UNIT SHOWING OUTLINE OF ROOF & WALL SECTIONS





Curtain height adjustable for best clearance.

Combustion products are more concentrated at side and end walls with high downward velocity acting as an air curtain to exclude cold outside air. This high velocity helps shield the refractory from iron dust and popping.

Fuel input is uniform across the bed.

Nozzle mixing type burners can use coke oven or natural gas without danger of flashback. Light oil standby available.

Burners are stable with large amounts of excess air.

High flame propagation rate permits inputs as high as 600,000 Btu per hr sq ft assuring good ignition even with self-fluxing sinter.

Water cooled support beams are not required.

Burner flames are adjustable from flat along the roof (for maximum radiance) to conical, overlapping at the bed.

Wall sections can be quickly and easily replaced without major shutdown.

Extra rows of burners and extra curtain walls can be added easily to increase the size of an existing hood.

Patent Pending

SEE US AT THE Iron & Steel EXPOSITION SEPT. 27, 28, 29, 30 CLEVELAND, OHIO

Call your nearby North American engineer or write to

The North American Mfg. Co.
Cleveland 5, Ohio

are electronically converted and computed by elements in a floor-mounted console. This equipment, in turn, activates a marking device which spray paints as much of the pipe end as is found to be below the thickness specified by the customer. In addition, the console gives the operator a reading of wall thickness variations on a wide-scale, zero-centered meter.

After the gage has probed the pipe for a distance equal to the travel of the carriage—about five feet—the unit is withdrawn. The measured and marked pipe is removed and sent on to the cutting machine for further processing. Meanwhile, another section of pipe is brought into position for gaging.

The gaging system has operated continually since the CF&I seamless tube mill was erected in 1953. Without the x-ray gage, CF&I would have to take a minimum crop on every length and then hand gage the pipe. Depending on pipe size and length, from 1 per cent to 5 per cent of the product would be found under-gage. The under-gage sections would then have to be recut. By making repetitive hand gaging unnecessary, the x-ray unit eliminates recutting and reduces space, crane service and manpower requirements.

FIREBRICK

△ The Babcock & Wilcox Co. has announced that it is placing on the market three new lines of firebrick recently developed by the company's Refractories Division.

Bearing the trade names of B&W KAO-HB, KAO-60 and KAO-70, the new high temperature firebrick are the result of a two year study by the company aimed at a broader range of quality firebrick and other refractories. Based on industry classifications, the KAO-HB is high burn superduty; KAO-60 is 60 per cent Alumina; and KAO-70 is 70 per cent Alumina firebrick.

POWER PLANT

△ Self-contained, automatically controlled gas-turbine power plants in ratings of 3000, 7000 and 12,000 kw have been announced by Westinghouse Electric Corp.'s Industrial Gas Turbine Department. Called ECONO-PAC plants, the units can be installed for as little as $80 per kilowatt.

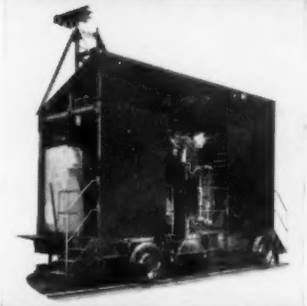
Designed for peaking, reserve capacity or emergency operation, the new units supplement the 22,000- and 44,000-kw peaking gas-turbine plants already available from Westinghouse.

The plants provide a quiet, unattended source of electrical power for a minimum capital investment. The entire plant requires only a flat concrete-slab foundation approximately three feet thick, plus electrical and fuel connections. This means that a unit can be in operation less than two weeks after delivery to the site.

The complete installed cost of the plants is in the order of $80 per kw based on winter operation, or $100 per kw for summer use—considerably less than the first cost of a conventional generating plant in this size range.

Evaporative inlet air coolers can be used to maintain full generating capacity when the dry-bulb air temperature exceeds 80 F. When ambient temperature is 40 F and

QUENCHER LOCOMOTIVE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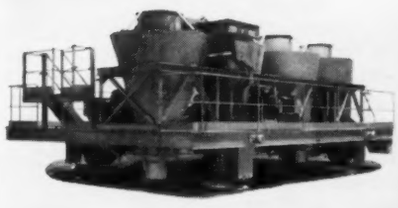
COKE ON THE MOVE

Operating economy and long life, again, are major advantages of Atlas equipment for highly specialized coke-producing service. Specially designed and ruggedly built to your exacting requirements.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COKE QUENCHING CAR

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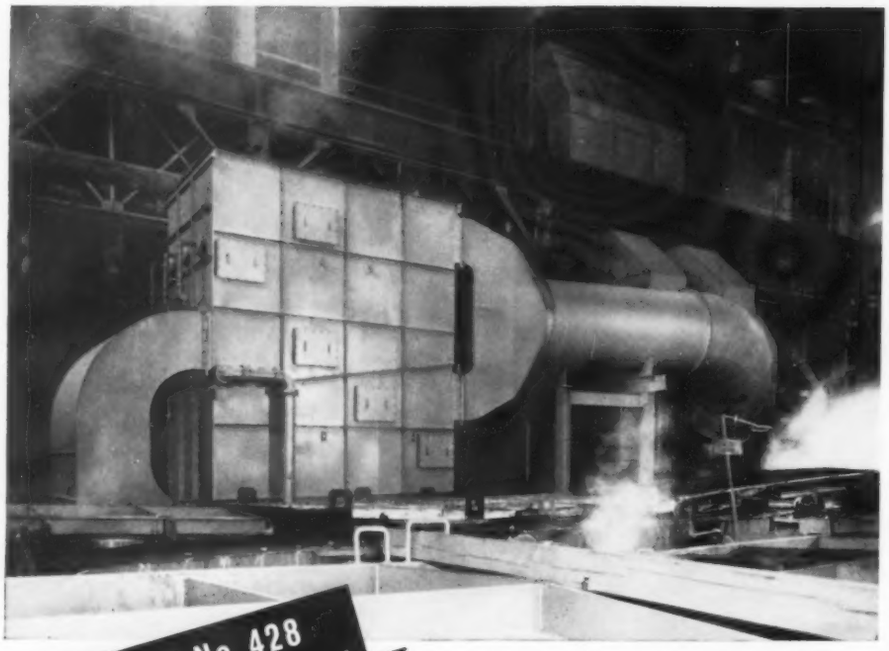

BOOTH No. 428
IRON & STEEL SHOW

Heil Fume Scrubber and Ducts in Pickling Room of Large Midwestern Steel Producer.

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Equipment for the *Steel Industry*

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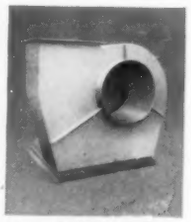
STEAM JET AGITATORS. Proven construction that assures uniform heating and efficient agitation. Rugged, durable special lead extrusions highly resistant to mechanical and thermal shock with Heil Nocordal Impervious Graphite Nozzles. Also solid Nocordal or all plastic construction for mixed acid applications. Standard or special designs for continuous or batch operations.

Heil Rigidon Solid Plastic 44" x 60" Rectangular Ell.

VENTILATION. Complete facilities including collecting hoods, ducts and fans built of Heil proven Rigivin (Rigid Vinyl) or Rigidon (Reinforced Plastic). *Nothing to rust.* Standard sizes to 108" in diameter. Experienced engineering assistance to survey your needs and recommend an efficient, economical, maintenance-free system.



Heil 25,000 C.F.M. Rigidon Solid Plastic Exhaust Fan.

FUME SCRUBBERS. Packed tower and wet cyclone types in solid plastic, lined steel, stainless or alloy construction. Water or caustic scrubbing solutions can be recirculated for greater economy. Heil Rigidon (solid plastic) Scrubbers are strong but light in weight, and usually can be installed on roofs without the added costs of reinforcing beams and trusses.

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below, the output of a plant is 25 per cent in excess of its 80 F rating.

GATE VALVE

Δ A series of new forged steel gate valves, completely redesigned to extend service life and facilitate maintenance, has been announced by the Industrial Products Group of Crane Co. Available sizes range from ¼ in. to 2 in.

Class XU Universal Trim, consisting of Exelloy disk and Stellite-faced seat rings is suited for steam, water, air, gas, oil, oil vapor, fuel oil, gasoline and similar needs; up to 1000 F on oil and oil vapor and 850 F on steam and general services. For special corrosive applications, Class L Trim is also available (18–8

SMo seats, disk and stem); maximum temperature 750 F, liquids and gases (except steam).

Structural features of the new valve include: (1) malleable iron wheel with nonslip gripping knobs (except on 2 in. size) with set-screws locking the wheel to the yoke sleeve; (2) the stem is heat treated Crane Exelloy, finished with a tapered shoulder for back-seating in the bonnet; (3) the ductile Ni-Resist yoke sleeve combines excellent bearing qualities, a high melting point and good resistance to atmospheric corrosion; (4) the two-piece ball-type packing gland will not bind even under uneven stress; (5) stainless steel swing-type eyebolts are hinged to the bonnet

氣

THE NOURISHING GAS

TO THE CHINESE
OXYGEN IS THE NOURISHING GAS.

To steelmakers in Britain and elsewhere, benefiting from the introduction of new oxygen steelmaking processes, the name couldn't be more apt. Oxygen is being increasingly used in the iron and steel industry. A converter furnace, employing oxygen for the blast instead of air, not only makes steel quicker than any other furnace, it produces steel of improved quality as well. Use of oxygen also enables the design of converter furnaces of much greater capacity, which means an installation of lower cost for any given output tonnage. Similar benefits accrue with any other steelmaking furnace. Faster production, better quality, reduced capital costs—strong nourishment in any language.
The design, engineering and supply of oxygen steelmaking plant up to complete melting shops is the main concern of Davy United's Steel Processes Division. In support of these services, the Division offers metallurgical, technical and economic surveys to help any company planning a new steelmaking development.

DAVY-UNITED STEEL PROCESSES DIVISION

SHEFFIELD, ENGLAND

(cannot fall off), and permit easy access for servicing.

The valve has a new "bow leg" yoke which is especially designed to provide extra hand room for repacking. A tee-head disk-stem connection gives a rugged coupling and prevents transfer of pressure loads to the stem.

The stuffing box has high quality packing consisting of diagonally cut rings with a braided asbestos jacket with flake graphite bonded to its exterior and Inconel wire inserts in each strand of braid over a core of asbestos and graphite. The bonnet joint is fitted with spiral-wound, Type 316 stainless steel gasket with asbestos filler which provides high resiliency and ensures tightness—the male and female joint assures alinement and correct gasket compression. The disk is Crane Exelloy, with long machined guide ribs preventing disk drag and reducing scoring and wear. Seat rings are shoulder-type of Stellite-faced Exelloy, rolled into the body.

SHEET LIFTER

△ Packs of sheet steel, ranging from 18 to 60 in. wide, are handled quickly and safely with a motorized rack and pinion type sheet lifter at Inland Steel Co.'s Indiana Harbor Works.

Designed and manufactured by the Materials Handling Division of Heppenstall Co., the lifter is used in Inland's Galvanizing Department for placing the packs in stacks and removing them from the stacks when needed. It will accommodate loads up to 31 in. high and weighing up to 20,000 lb.

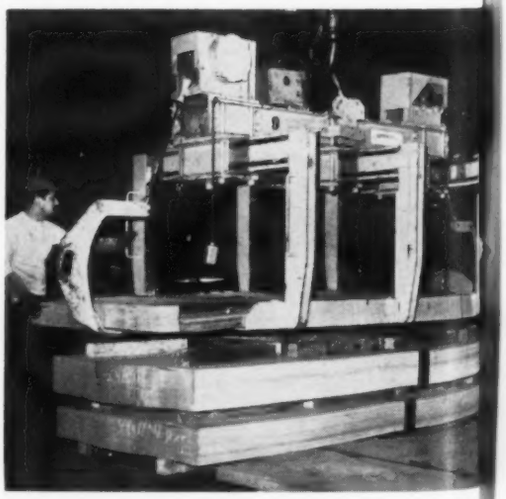
The rack and pinion type lifter was selected because it permits handling loads with great variation in width, but requires little headroom. Designed primarily for loads up to 120 in. long, the lifter will accommodate even longer loads by the use of end grabs.

The lifting arms move in and out in a straight line. Clearance of 14 in. on each side of the pack to be lifted is sufficient.

Wooden 4 by 4's are used for vertical separation of the packs in a stack. This allows ample clearance for the lifting arms to move under a pack.

Raising and lowering of the lifter is controlled by the crane operator from his cab. The lifter is lowered over a pack with its arm opened wide enough for clearance. When it

Crane follower uses bar at end of motorized sheet lifter to position a pack of sheet steel above another. Note the hand ring at each end of lifter for operating springs that raise or lower the end grabs, and the push button pendants for controlling horizontal motion of the lifting arms.



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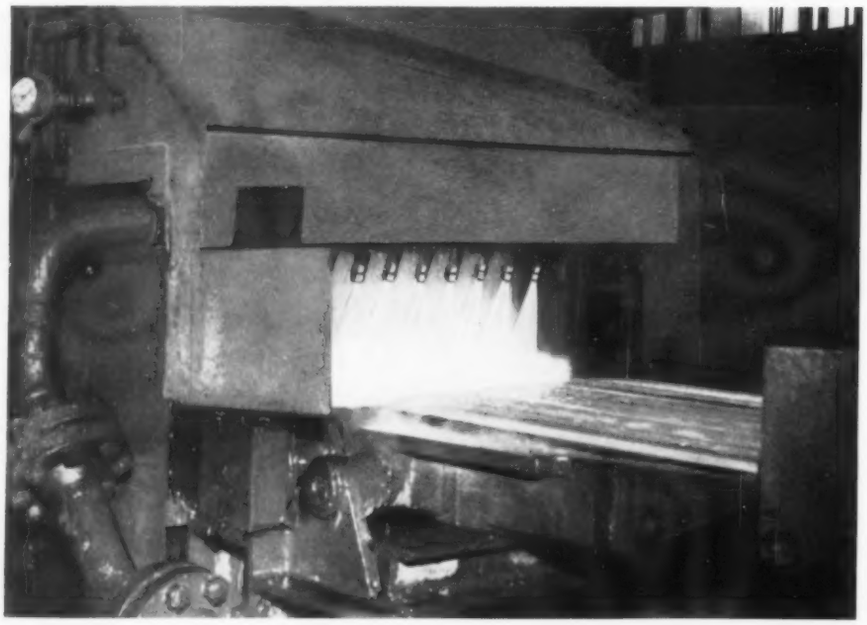
DESCALING SYSTEM
meets the strict requirements of manufacturers wherever clean and scale-free steel is required.



It is necessary for the manufacturing of all products that require indentment free sheets for High Gloss Finish.

Are you getting enough pressure in your Descaling System? Consult Titzel!

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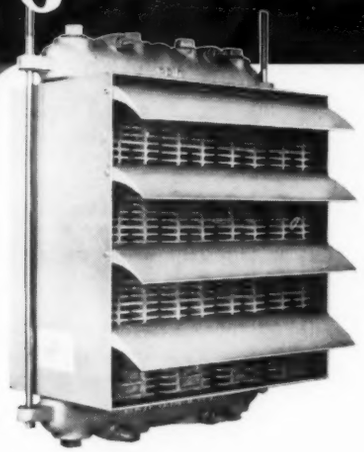
GRID's got to be good!



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LOOK at the plants that depend upon GRID

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BLAST HEATERS
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for a trouble-free, low maintenance cost heating system - One that will serve without service - Installations made in 1929 are still operating without need for repairs. GRID'S design and construction makes the difference!

GRID Cast Iron Construction resists corrosion externally from acid fumes and internally from electrolysis. No leaking from rotted cores.

GRID one-piece cast iron heating sections and headers are leak-proof on steam pressures up to 250 p.s.i. 450° temperature. Smaller steam lines cost less.

GRID heating sections with widely spaced fins cast integral with steam chambers are easy to clean - Will not "mat" on air intake side.

GRID design develops low outlet temperatures and with proper fan volumes, delivers warm, comfortable air to floor - No wasted heat at ceiling.

Get complete information on a GRID System for your plant. Write for catalog #956 GRID CAST IRON STEAM HEAT TRANSFER SURFACE.

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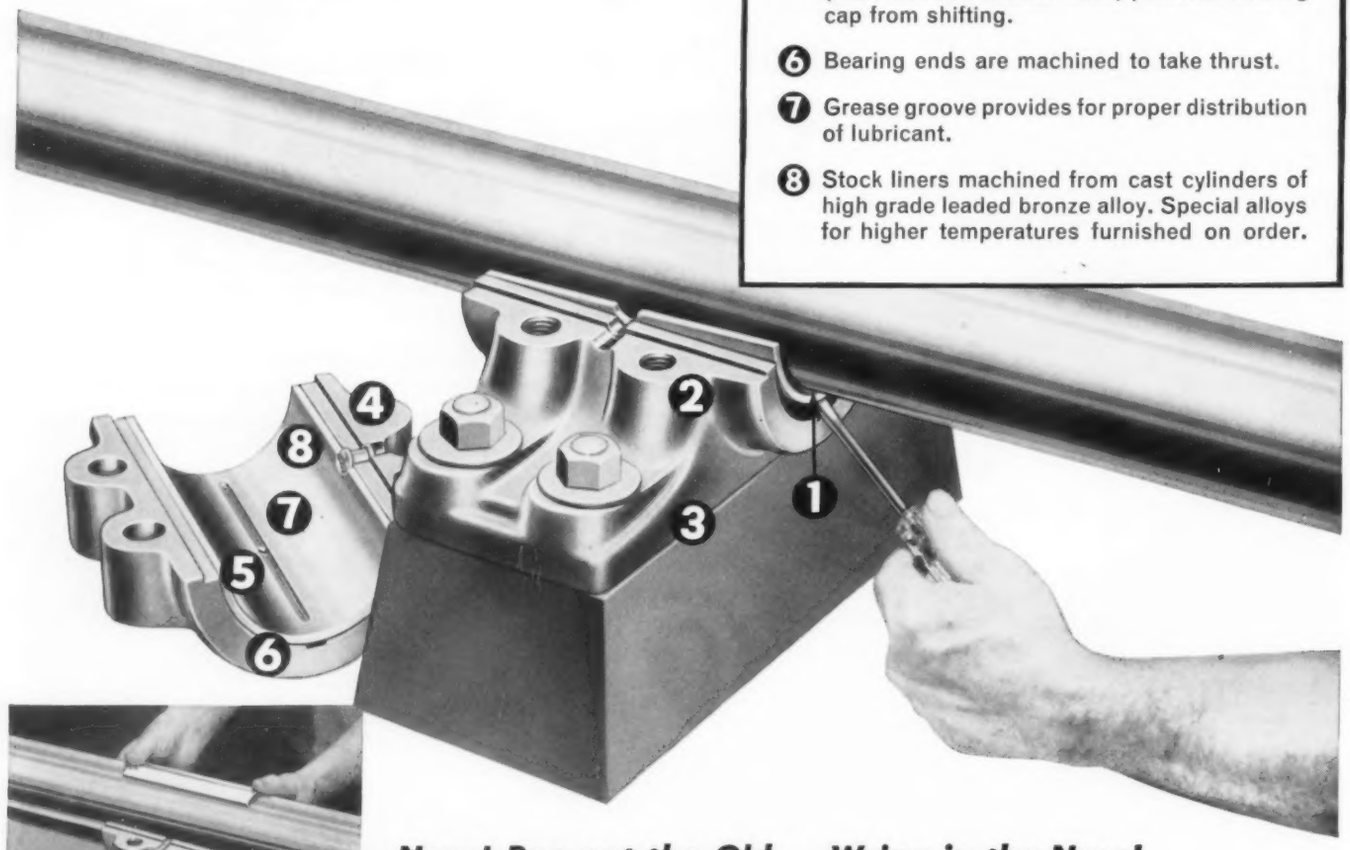
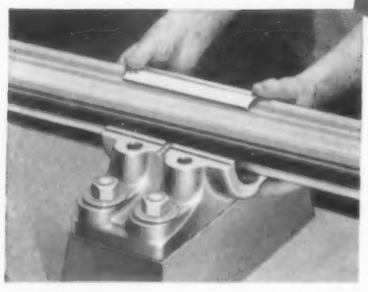
Manufacturers Since 1883
WAUSAU, WISCONSIN

ANNOUNCING A NEW IDEA IN BRONZE BUSHED BEARINGS ...A PRECISION LINER THAT IS REPLACEABLE ON THE JOB!

—see it demonstrated at the Cleveland Show—Booth 621

1. Precision bronze liner, replaceable without removing shaft or bearing base.
2. Rugged semisteel housing to withstand heavy shock loads. (Ductile iron or steel to order.)
3. Bottom of base machined for perfect alignment; close tolerance held to center of bore.
4. Brass spool locks both halves of bronze liner—prevents lateral movement and rotation. No pins, no screws. (Patent applied for.)
5. Tongue-and-groove joint in 4-bolt base sizes (fitted bolts in smaller sizes) prevents bearing cap from shifting.
6. Bearing ends are machined to take thrust.
7. Grease groove provides for proper distribution of lubricant.
8. Stock liners machined from cast cylinders of high grade leaded bronze alloy. Special alloys for higher temperatures furnished on order.



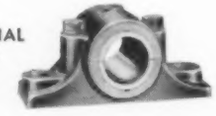


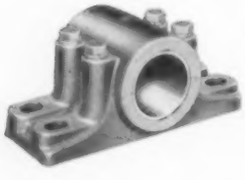
Now! Pop out the Old...Wring in the New!

This new idea in quality bronze bushed bearings for heavy loads, high temperatures and corrosive conditions minimizes loss of downtime and hard work of replacing liners. Simply relieve shaft pressure, remove the old liner and roll in the new. No premium price. Ask your local Dodge Distributor. Or write us for bulletin.

Dodge Manufacturing Corporation
5900 Union Street, Mishawaka, Indiana

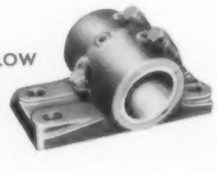
SPLIT BRONZE BUSHED JOURNAL BEARINGS — 1 15/16" to 2 15/16"





RIGID BRONZE BUSHED PILLOW BLOCKS — 3 7/16" to 8"

ANGLE BRONZE BUSHED PILLOW BLOCKS — 1 15/16" to 8"



DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

is positioned, the crane follower operates a push button control, causing the arms to close on the pack, holding it firmly from beneath while lifting it. A slip clutch in the motor drive prevents damage to the sheets and to the drive mechanism. A self-locking mechanical brake maintains the lifting arms in a fixed position.

After the load is safely delivered, and again rests on a firm surface, the crane follower uses the push button to open the arms for clearance, releasing the load.

For maximum convenience, duplicate controls are located at each end of the lifter. In addition, bars are provided for turning the lifter slightly as a pack is being positioned above another to compensate for leeway allowed by the crane hook.

Each of the end grabs is raised and lowered by an individual spring retriever with an individual position and lock control. To use the grabs, the crane follower puts each one in position under the pack, and the spring action tightens the grab against the underside of the pack.

REFRACTORY

△ Norton Co. has announced the development of a new high temperature refractory product, known as Crystolon "63," which is expected to have wide application as a relatively low cost structural ceramic, high in physical strength and resistance to attack by heat and molten salt. It has been used experimentally as a lining in aluminum reduction cells and test results indicate that wall thickness of the cell linings can be reduced about 75 per cent. In addition, substantially less electric power is required to operate the cell.

Crystolon "63" is a silicon nitride bonded refractory. While it was originally developed to meet the need for better refractory linings for aluminum reduction cells, it is suitable for use in such other applications as melting and alloying high purity, expensive metals; transferring molten materials; as structural ceramic for package boilers, incinerators and in kiln furniture for the ceramic industry. It is also being evaluated for use in rocket nozzles and blast pads at launching sites.

EXTRUSION PRESS

△ Seamless aluminum cans are being impact extruded at the rate of 120 per minute on a new 300-ton Impact Extrusion Maxipres unveiled by The National Machinery Co. The press delivers the cans in an oriented manner ready for trimming, flanging, cleaning, coating, filling and closing.

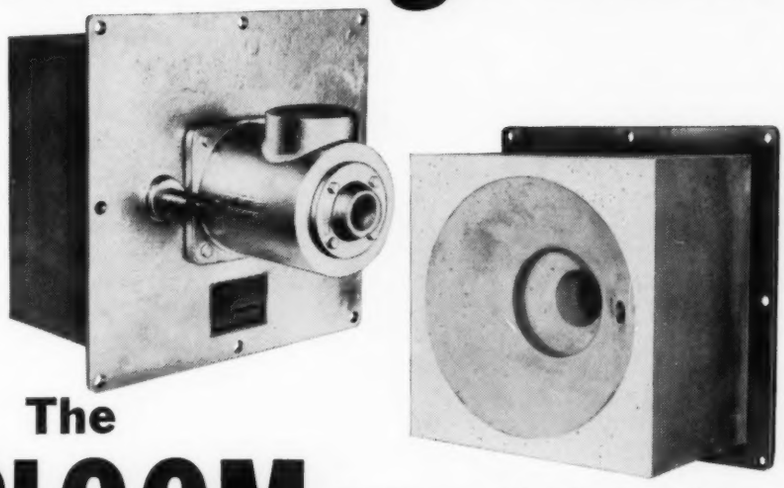
The cans, which start as disks $\frac{1}{8}$ in. thick and $2\frac{1}{2}$ in. in diameter, have a height of over 5 in. as they emerge from the machine.

The 48,000-lb press has a rugged cast steel bedframe capable of absorbing the shock of impact extrusion. A simple die adjustment varies the bottom thickness of the can while the press is running. A tonnage indicator shows the tonnage generated during the press cycle.

FLOW SWITCH

△ Syntron Co. announces the development of a flow switch, Model FS-1, designed to respond to the lack of material at a critical point in a bulk material handling system and automatically correct the difficulty or sound an alarm.

Focus High Heat



The BLOOM HTR BURNER

The Bloom High Thermal Release Burner can be located in a furnace roof or wall to give the operator the temperature he needs for a given area. Maintenance on this burner is minimized, since alloy or cast iron parts aren't exposed to high temperature.

Applications include:

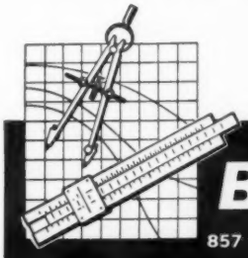
Tube Upsetting

Continuous Strip Pre-Heating, Annealing, Coating, and Drying

Batch type Forging

Aluminum Chip Melting

Meta-Silicate Melting



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ENGINEERING • EQUIPMENT • SERVICE

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. . . . . for air separation plants designed for steel mill applications, think *first* of American Messer.
AMERICAN MESSER CORPORATION
Chrysler Building, 405 Lexington Ave.
New York 17, N.Y.

The flow of material past the switch deflects the flap and holds it out of operating position. When the flow of material stops and there is none to hold the flap in a deflected position, it swings back into operating position and actuates the switch. The switch may start and electromagnetic bin vibrator to break down arching or plugging in a bin, hopper or chute, that may be causing the shortage of material. It may start or stop a vibratory feeder supplying a bin. An alarm system, either manual or audible, can be set up by using the flow switch as the energizing agent.

A number of switches can be used in one system—each located at a critical point. They can be installed in all types of feeder and conveyor troughs—in the discharge openings of bins, bunkers and hoppers—in angled or vertical connecting chutes —and in the discharge chutes of dryers, crushers, ball mills and other processing equipment.

The switches are sturdily constructed to provide a long trouble-free, maintenance-free life. The shaft to which the flap is attached is mounted in ball bearing pillow blocks. The actuating angle of the flap as it affects the switch is adjustable through 360 deg.

Switch rating is one ampere at 115 volts, 0.5 ampere at 230 volts, a-c.

UNCOILER

△ The Waldron-Hartig Division of Midland-Ross Corp. announces a new design rotating two station uncoiler for steel and aluminum strip. Recent installations of this model are operating successfully in the plants of four aluminum and steel strip manufacturers. These initial installations are operating in continuous Ross/Waldron "Strip Coating" lines.

The Model 12,000 is designed to handle coils with diameters up to 60 in., widths ranging from 18 in. to 66 in., and with maximum weight of 12,000 lb per coil.

The Model 12,000 Uncoiler is quickly adjustable, through the centralized control panel, to various coil diameters, and to various coil widths, which are centered with respect to "in line" operations. The cantilever arms, which are

(*Please turn to page 343*)

FURNACES
TO HEAT TREAT OR SHAPE METALS MORE EFFICIENTLY
CAR HEARTH FURNACES
ROTARY HEARTH FURNACES
PIT-TYPE FURNACES
HI-HEAD FURNACES
BELT TYPE FURNACES
CHAIN CONVEYOR FURNACES
Write for technical data and catalogs on the above and many other R-S Furnaces to . . .
R-S FURNACE COMPANY, INC.
North Wales, Pa.
R-S
FURNACES

Pre-Engineering by **KAISER ENGINEERS** answers basic plant expansion questions...

Profitability? Faced with the decision to expand your plant facilities, you should first determine whether all elements combine to form a pattern of future profitability. Independent analysis of all aspects of your proposed program is the *Pre-Engineering* service offered by Kaiser Engineers. The studies and evaluations furnished by KE Pre-Engineering represent only one phase of total KE services. Kaiser Engineers designs and builds for the Steel industry...offers skilled experience in all types of facilities from raw material plants to finishing mills. From Pre-Engineering through design and construction, Kaiser Engineers provides complete one-company service and ingenuity based on years of experience.

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FOR QUALITY... PRODUCTIVITY ... PROFIT

METAL ROLLING AUTOMATED BY GENERAL ELECTRIC

A NEW CONTROL FOR REVERSING HOT MILLS

G-E program-control system operates

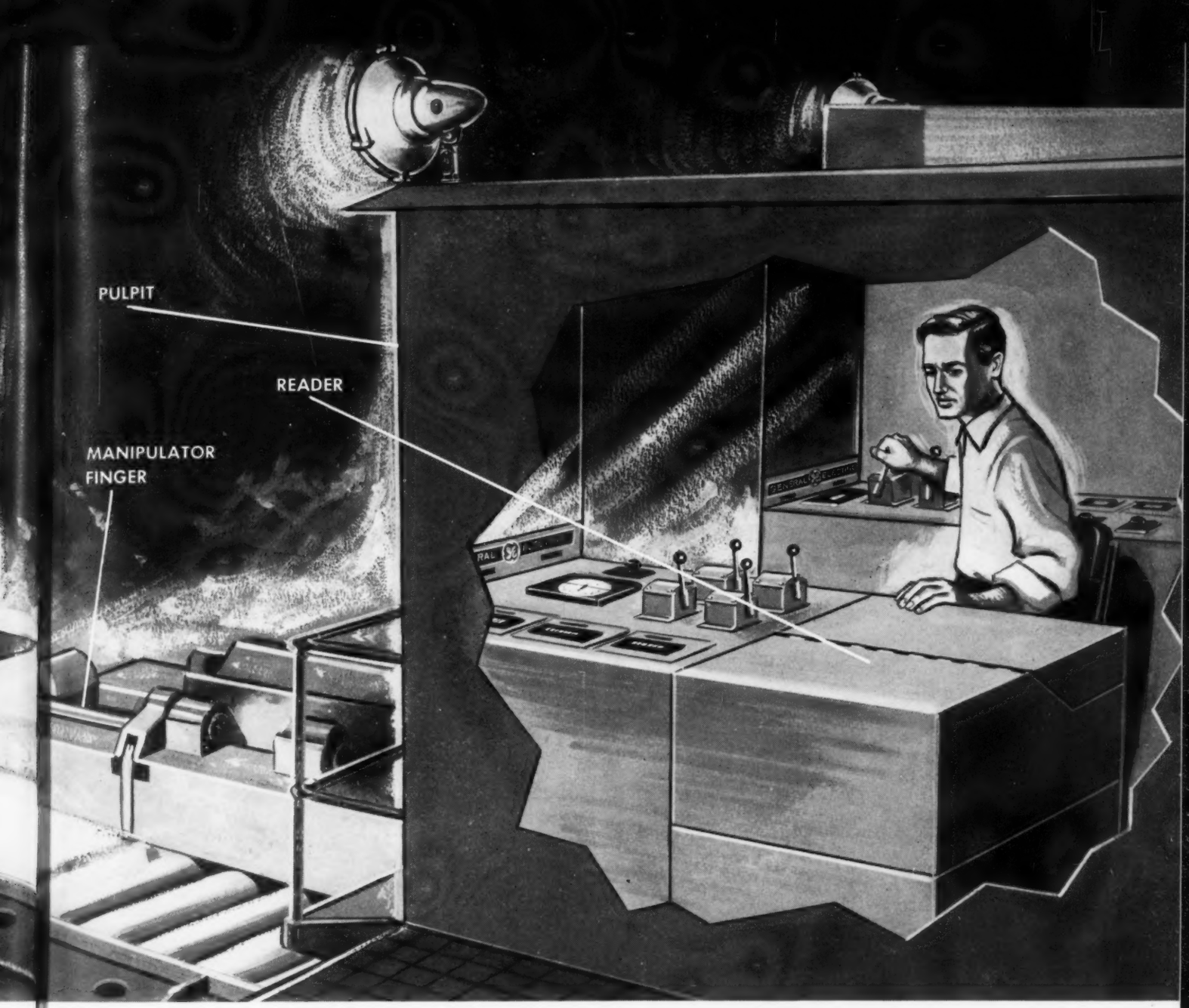
General Electric's new program control for reversing hot mills performs an entire rolling cycle—automatically. Increased yield per ingot, substantially improved product quality and reduced unit cost are outstanding advantages of this new control system.

HOW G-E PROGRAM CONTROL OPERATES

The entire rolling operation, from ingot entry to finished slab, is controlled automatically. A punched card or other memory device is used for data storage and to control the entire operating sequence.

The cards are punched to perform mill functions previously determined to be the most efficient for the equipment involved and the product desired. This controlling element is read by an industrial card reader, which sends impulses to the control circuit and on to the screwdown motors, mill table drives, and manipulator drives. The operator, seated in the pulpit, inserts the card into the reader, depresses a pushbutton, and then the control directs the entire operating sequence. The speed of the mill table, position of the rolls, manipulation of the piece, and sequencing operations for all passes are controlled automatically by the program control system.

Yield is increased—The General Electric program control schedules the mill tables to run at the most desirable and efficient speed. It also brings the rolls into the position calculated for maximum ingot reduction on each pass and turns the ingot at the exact time determined to produce highest slab quality. This precision control produces more finished slabs per turn than manually controlled mills.



entire rolling cycle — automatically

Quality is improved—Greater slab uniformity is obtained with G-E automatic program control. Consistent roll settings and mill speeds produce uniform slabs. This improved quality control also results in substantially less scrap.

Unit cost is reduced—Automatic programming produces finished slabs faster than ever before possible. Higher operating efficiency of machinery and faster equipment adjustment by automatic control cut production time—therein reducing unit cost.

Get all the facts on this new automatic control for steel mills. Contact your G-E Apparatus Sales Engineer today, or write to Sect. 785–10, General Electric Company, Schenectady 5, N. Y., for bulletin GEA-6869. Industry Control Department, Salem, Virginia.

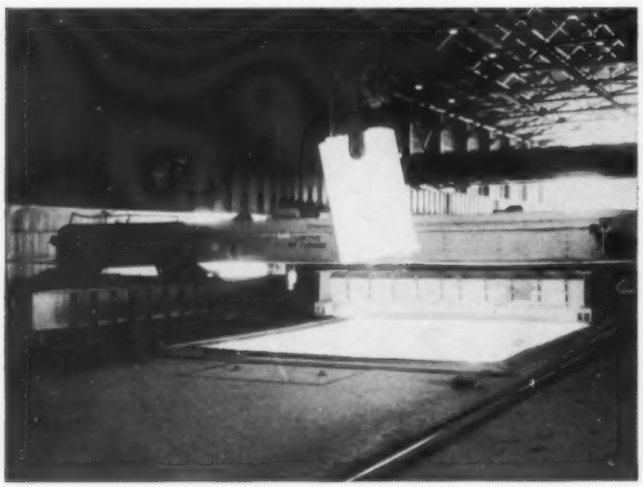
Progress Is Our Most Important Product

GENERAL ELECTRIC

Open Hearth Furnaces—Photo Courtesy
Jones & Laughlin Steel Corp.

Continuous Heating Furnaces—
Photo Courtesy Crucible Steel Co.

Soaking Pit—Photo Courtesy
United States Steel Corp.



Heat Treating Furnace—
Photo Courtesy Taylor Forge & Pipe Works

Increase Production . . . Lower Production Costs with

LOFTUS Industrial FURNACES

For years Loftus Industrial Furnaces have been providing dependable, economical service to the steel industry. Their long life and efficient performance have been proved by time. The fact that they materially contribute to lower-cost operation and increased production is a matter of record.

Whatever your heating or heat-treating requirements, it will pay you to take advantage of Loftus' long experience in furnace design and construction. Many of the world's leading companies have—and to their utmost satisfaction, as proved by the high percentage of repeat orders we get.

We would welcome an opportunity to quote on your requirements.

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From first heat to heat treat, look to **LOFTUS**

Engineering Corporation

1 Gateway Center, Pittsburgh, Pa.

56•23•3

(*Continued from page 338*)

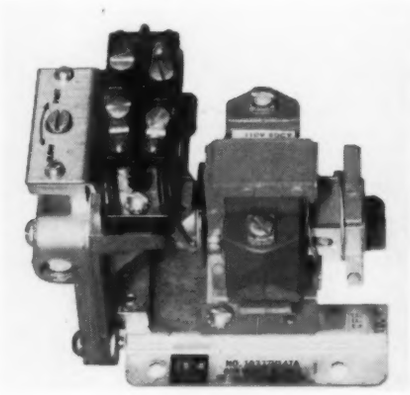
mounted on lateral slides each have an expanding mandrel for ease of coil pickup and release.

The required strip tension is provided by electric brakes mounted on each of the arms. Turret rotation is controlled by an a-c electric motor.

TIMING RELAY

△ A unique one-minute pneumatic timing relay which sets higher operating standards on such applications as machine tool and sequence controls has been developed by engineers of Cutler-Hammer.

Keynote of the new design is simplicity. The company has developed a diaphragm assembly which eliminates the need for an



exhaust valve. The timer maintains accuracy and reliability even in the dustiest environments through a self-cleaning filter system that protects the timing assembly from the destructive effects of all airborne foreign material. In the timer, exhaust air is forced back through the intake filters to blow them free of dust which may have collected during intake.

Another key design feature is greater ease in selecting time settings. The relay's adjustment screw takes seven complete turns—more than any other design—to insure positive, accurate adjustment over a range from 0.2 to 60 sec.

Easily convertible from "on delay" to "off delay," the device also features unit construction, molded magnet coil and a precision unit switch. The switch is suitable for pilot and control circuit duty to a maximum of 600 volts.

For even greater reliability, the diaphragm is made of silicone rubber and will operate dependably in temperatures as high as 150 F or as low as −45 F.

ROLLING OIL BASE

△ Reduction of power requirements, cleaner strip and elimination of cleaning prior to annealing are all claimed for a new rolling oil base developed by Baker/Gubbins Co.

The product replaces palm oil, sperm oil and similar rolling oils. It conditions the steel surface, increases corrosion protection and is said to prevent scratching and scuffing when applied at the pickler oiler.

The compound (No. 717) can be diluted with mineral oil to form a stable oil, or may be mixed with hot water to form a metastable emulsion.

Book Reviews

"Temperature Induced Stresses in Solids of Elementary Shape"

(*Please turn to page 347*)

Get larger neck to roll ratios in enclosed designs!

Average thickness of A-B-K bearing = ⅞".

Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A·B·K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

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LAMINATED
PHENOLIC BEARINGS

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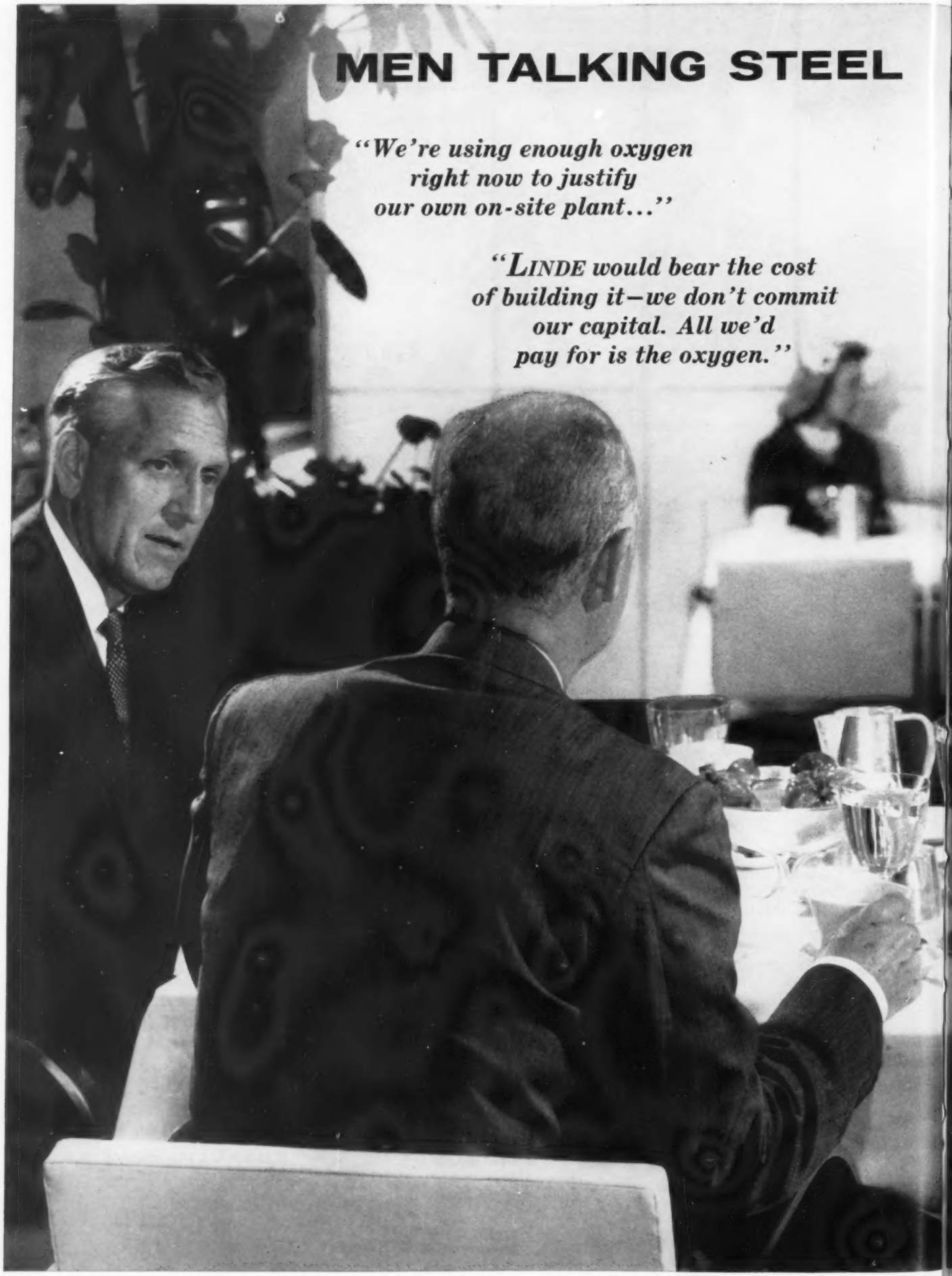
AMERICAN Brake Shoe COMPANY
AMERICAN BRAKEBLOK DIVISION
P. O. BOX 21, BIRMINGHAM, MICHIGAN


MEN TALKING STEEL
"We're using enough oxygen right now to justify our own on-site plant..."
"LINDE would bear the cost of building it—we don't commit our capital. All we'd pay for is the oxygen."

ARE TALKING LINDE OXYGEN

"With several times the back-up capacity of anyone else, LINDE can always meet emergency calls too."

"More reasonable than I expected."

To get the full set of facts on how LINDE applies *total gas technology* to on-site plants for the steel industry, write Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada*, Union Carbide Canada Limited, Linde Gases Division, Toronto 12.

LINDE COMPANY

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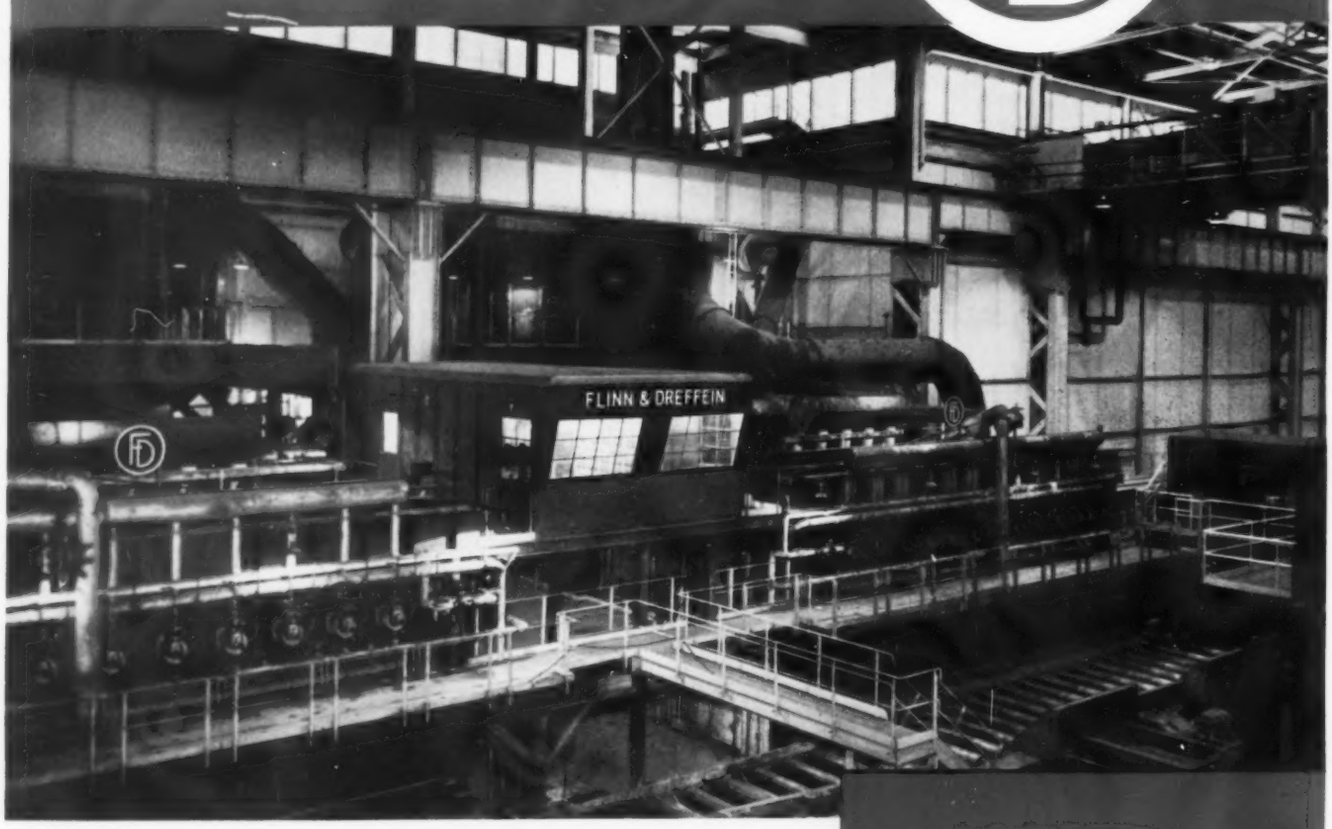
. . . another first by Flinn & Dreffein . . .



Two new "Flinn & Dreffein Designed" 5-zone reheat furnaces made news recently when they were placed in operation at the new structural mill of United States Steel Corporation's South Works plant at Chicago.

The demand for larger sections, tonnage capacities and flexibility of heating operation dictated this advanced design.

Once again, Flinn and Dreffein experience and know-how reflected by user's confidence inspired Flinn and Dreffein engineers to further the development of reheat furnaces using the latest techniques and materials in furnace design.

F & D Furnaces . . . for more than half-a-century . . .

ANNEALING
CARBURIZING
DRAWING
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GALVANIZING
HARDENING
HEAT TREATING
NORMALIZING
REHEATING
ROTARY
SLAB HEATERS

Gas and oil fired or electrically heated.

FLINN & DREFFEIN ENGINEERING CO.
36 S. Wabash Ave., Chicago 3, Ill.

(*Continued from page 343*)

(National Bureau of Standards Monograph 2) by L. H. Adams and R. M. Waxler, has been published recently by the National Bureau of Standards, U. S. Department of Commerce. The book contains 27 pages and can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 25¢. This publication presents equations in convenient form for calculating the stresses in solids of certain shapes when subjected to (a) a sudden change of surface temperature or (b) a surface temperature that increases or decreases at a constant rate. Tables of certain temperature functions are given as a means of quickly determining stresses in a slab in a cylinder, or in a sphere subjected to either of two modes of heating. The temperature tables independently will provide a useful means for the ready estimation of temperature gradients. (Foreign remittances must be in U. S. currency and must be increased 25 per cent over publication price to cover mailing costs.)

"Energies of the Universe" by Eugene Fritz has been published recently by Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. This book contains 124 pages, 6 x 9 in., is cloth bound, and sells for $4.75. In this account of natural phenomena as understood by modern science, this book contains a host of facts and figures to support the view that the education of present scientists is in many instances based on misconception, and is now obsolete. It contradicts the notions of the origin of atomic energy, temperature factors in the heat of nuclear energy, and temperature factors in the heat of the sun, and explains that the energy, and the structural forces of every universe, are generated in the same manner.

"A Structure of Science" by Joseph H. Simons has been published recently by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 269 pages, 6 x 9 in., is cloth bound and sells for $4.75. This book shows what science is, what it is not and how it fits into the framework of human knowledge and experience. It deals with the basic intuitive concepts of science and shows their mutual relationships, their relationships to the useful abstractions of space and time and to common experience; and an effort is made to resolve some of the apparently conflicting consequences of certain scientific beliefs.

"Techniques of Plant Maintenance and Engineering" (Volume XI) has been published recently by Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. This volume contains 341 pages, 8½ x 11 in., is bound in cloth-on-board, and sells for $10. This book reports on the advance of automation from research and experiment to reality, and on the significance of automation in maintenance operations. It is a report of the proceedings of the technical sessions held concurrently with the national plant maintenance and engineering show, Philadelphia, January, 1960. It contains the 34 papers presented at the

(*Please turn to page 356*)

. . . withstand temperatures to 3,500° F., extreme abrasion, slag formation

These refractories form exceptionally stable, non-wetting linings that have amazing load-bearing strength and resistance to ferrous metal penetration.

80-95% Alumina . . . New Pli-Ram Mixes are specially formulated from select ores for high temperature installations where molten aluminum and iron oxide are the chief causes of lining failure.

Specially formulated for these and similar installations:

- Aluminum remelt furnaces
- Brass and aluminum ladles
- Ladles for carbon and alloy steels
- Electric furnace roofs
- Slab reheat hearths
- Foundry mixing ladles

Pli-Ram "80" (heat setting)
Pli-Ram "80-S" (chemical and heat setting)
Pli-Ram "90" (air setting)
Pli-Ram "95" (air setting)

WRITE FOR LABORATORY REPORT PLR-935-A.
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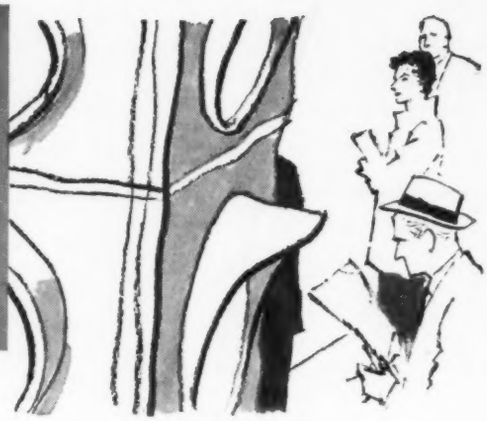
"How do you feel Savings Bonds match up against common stocks as an employee investment?"



"You really can't compare the two, Jimmy! As you know so well, every good investment plan needs a sound backlog of basic safety and you need some savings before you branch out with anything else. Now, we don't know of ANY sounder, safer form of saving than U.S. Savings Bonds. We felt we were doing our people a real favor by asking our State Savings Bond Director to help us explain the Payroll Savings Plan to every person on our payroll.

"Until we put on this company-wide campaign, lots of people in our company had no idea they could set up a regular, *automatic* savings plan by just signing one card. They welcomed having someone to answer their question *in person*, and it appealed to their pride to be made a part of the company group contributing to our country's economic welfare.

"And, Jimmy, here was another thing we found out. Many of our employees didn't realize that since U.S. Savings Bonds now earn 3¾% they are the best investment they have EVER been!"

Perhaps there are employees in *your* organization who don't know what a splendid base for family savings U.S. Savings Bonds really are. Perhaps they don't realize how easy it is to start NEXT PAYDAY with regular, systematic savings for important future goals.

Your State Savings Bonds Director has a fine background of experience in presenting the Payroll Savings Plan. For fast, understanding help, get in touch with him now. Or write Savings Bonds Division, U.S. Treasury Department, Washington, D. C.

NOW! U. S. SAVINGS BONDS EARN 3¾%

ADVERTISING COUNCIL PUBLIC SERVICE

IRON AND STEEL ENGINEER

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE.

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USS

Shaw-Box Ladle Crane. A 4-girder, 9-motor crane with 54 foot span. 90-ton ladle holds 200 tons of molten steel. 75-ton auxiliary trolley handles lighter loads.

Shaw-Box Bucket Magnet Gantry Crane. Our gantries are used to handle plate, slabs, ingots, and scrap. They are built to obtain freedom from whipping and to resist impacts.

These 10 top steel companies solve handling problems with Shaw-Box® Cranes

Standard crane designs of 30 years ago can't solve materials handling problems for today's steel mills. Problems unique to each mill demand cranes especially engineered for the job.

That is why these ten leading steel companies developed their own crane specifications — or chose modern AISE standards. Each awarded the job of constructing the crane to Shaw-Box.

Shaw-Box produces cranes of any type and capacity to AISE standards or your own. Your particular materials handling problems come first. We are not bound by traditional concepts of design. The crane you want is developed for top efficiency, easy maintenance, power economy, and complete safety.

Call in one of our engineers. He will gladly discuss specifications and tell you about our standard AISE designs for 5 to 500-ton cranes. We welcome the opportunity to serve you.

MAXWELL MANNING & MOORE INC. TRADE MARK

60 K-2

SHAW-BOX® CRANES

A product of

MANNING, MAXWELL & MOORE, INC.

ELECTRIC OVERHEAD CRANE INSTITUTE E.O.C.I. MEMBER

Shaw-Box Crane & Hoist Division • Muskegon, Michigan
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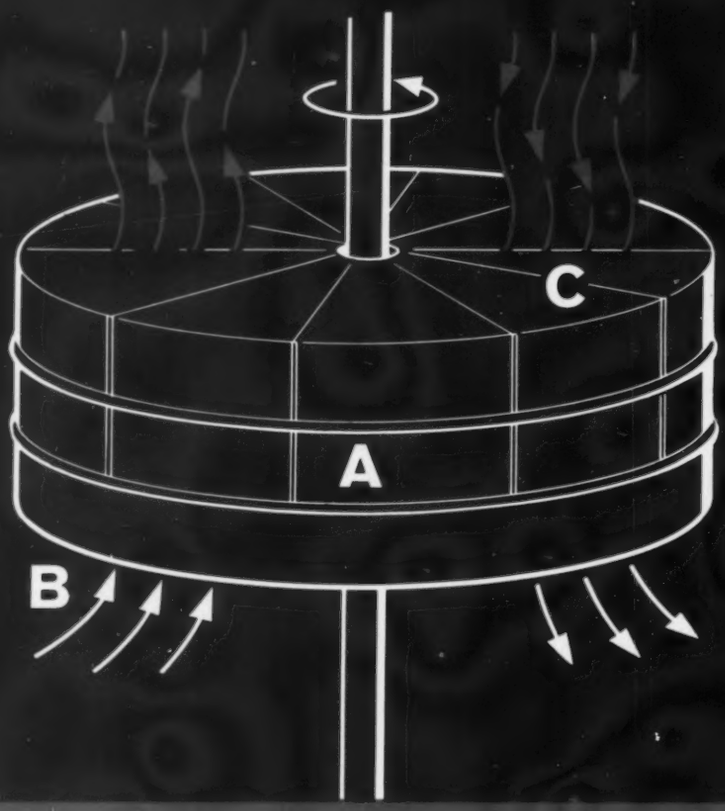
COMPACT ROTARY HEAT EXCHANGER NOW AVAILABLE FOR STEEL INDUSTRY



Rotary regeneration makes the Ljungstrom more efficient than any other heat exchanger because the heat is absorbed by, and released from, **the same metal surface.** Heat recovery is continuous and uniform. All the heat exchange elements are contained in the rotor (A). Exhaust gases (B), diluted with air if necessary, pass through half the rotor and heat the elements. As the rotor revolves, these heated elements pass through the counterflow incoming air at (C). The incoming air absorbs the heat and carries it back to the combustion chamber. The Ljungstrom can be adapted to either horizontal or vertical flows of gas.

Example: Can preheat air from 70° F to 1380° F

The Ljungstrom® Air Preheater is the most efficient metallic heat exchanger ever developed. It's the only heat exchanger *of any type* that, with an exhaust temperature of 1500°F, can raise incoming air from 70°F to 1380°F—and do it in so little space. A Ljungstrom measuring about 5′ x 7′ x 8′ can handle a furnace exhausting 30 x 10^6 Btu/hr.

It's the continuous rotary regenerative principle that makes the Ljungstrom so efficient and so compact. Essentially, this rotary principle (explained more fully in the diagram above) permits the accumulation and release of heat by the same surface, thus reducing the surface required to recover a given amount of heat.

Another Ljungstrom characteristic is absolutely uniform air preheating. The slowly revolving Ljungstrom rotor heats incoming air continuously, so you get a *steady high temperature* instead of fluctuations typical of cycling checkers. And because of the depth of the heating elements—two to three feet—the heating surfaces can be readily cleaned to maintain continuous maximum recovery.

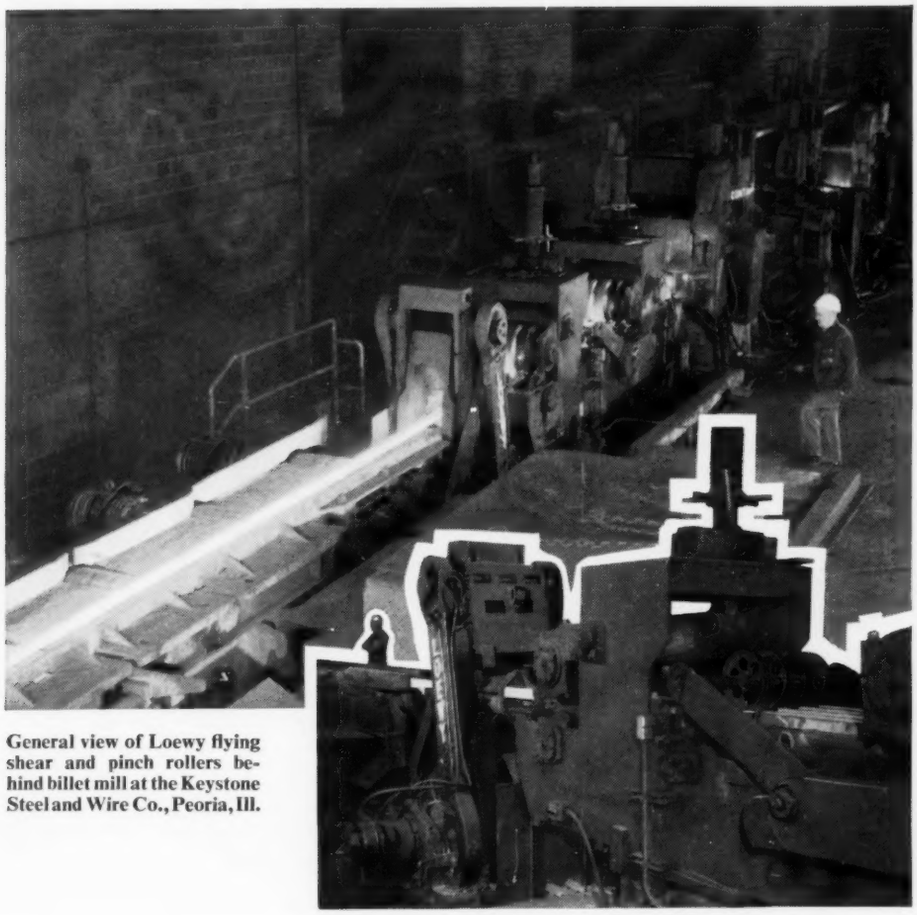
Ljungstroms have been used with many types of fuel, including crude and refinery oils, coke-oven gas, natural gas and blast furnace gas. Applications include industrial and utility boilers, high temperature refinery stills, and special industrial processes of many types.

Present high-temperature designs accommodate exhaust gases to 1500°F, and Air Preheater is developing and testing designs for temperatures well above 2000°F. The Ljungstrom Air Preheater has many potential steel mill applications: soaking pits, slab, billet and skelp heating furnaces, etc. For further information on the Ljungstrom Air Preheater and its possibilities for heat recovery in steel mills, phone or write to:

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.
MUrray Hill 2-8250

KINEMATICS--the reason why Loewy flying shears perform with unerring accuracy



General view of Loewy flying shear and pinch rollers behind billet mill at the Keystone Steel and Wire Co., Peoria, Ill.

Close-up of flying shear as viewed from pinch roller side

Billet approaching flying shear

Shear cycle starts

Cutting operation

Cut finished

Installed behind a continuous billet mill, the electrically operated Loewy oscillating flying shear is indeed an extraordinary precision tool. Its speed is synchronized with the speed of the mill. Its adjustability conforms exactly with the material coming from the mill. Sequence of cuts and cut length of material can be changed at will.

The kinematics of the knife blades—a patented feature of Loewy flying shears—is the dominant factor in achieving clean cuts without any distortion of the billet. For each individual cut an automatic oscillating lever mechanism actuates the shear and then returns the blades to their initial position at the end of the cycle.

The flying shear is a part of the complete Loewy billet handling system: skew-roll grouping tables behind the shear, billet cooling beds, and runout tables from where the material is selectively kicked off into collecting pockets. The shear itself can, of course, be furnished for an already existing system.

All B-L-H machinery is designed and built to our customers' requirements. B-L-H's Industrial Equipment Division builds Loewy rolling mills and auxiliary equipment, as well as Loewy hydraulic machinery. To avail yourself of our services, write Dept. **C-9.**

Visit us at Booth No. 504, AISE Show September 27-30, Cleveland Public Auditorium Cleveland, Ohio	Visit us at Booth No. 1226, NMTBA Show September 6-16, Amphitheatre Chicago, Ill.

BALDWIN · LIMA · HAMILTON

Industrial Equipment Division • Philadelphia 42, Pa.

WHAT HAPPENS WHEN A NATION SPENDS MORE ON GAMBLING THAN IT SPENDS FOR HIGHER EDUCATION?

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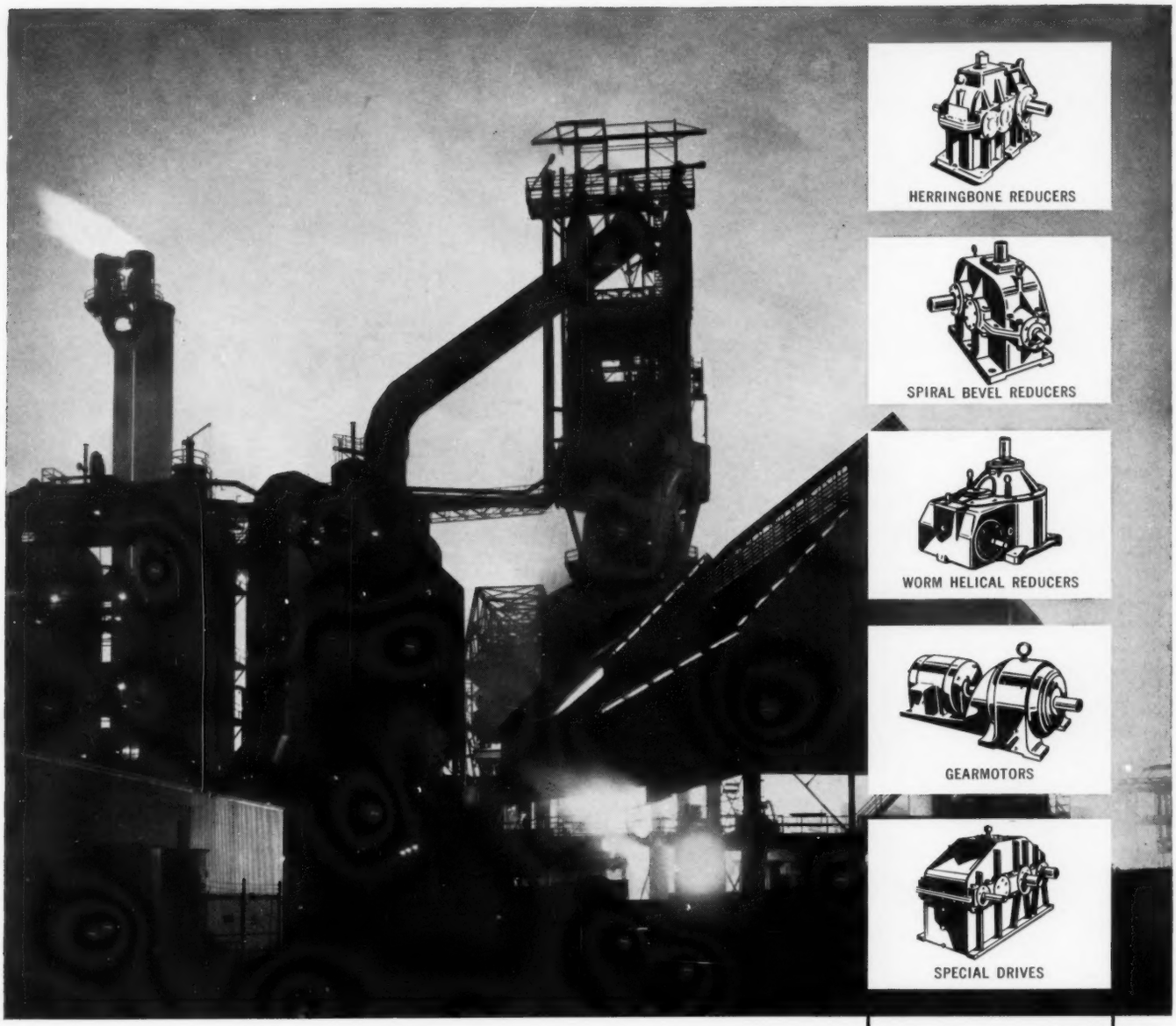

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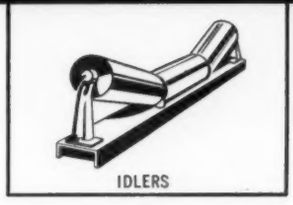
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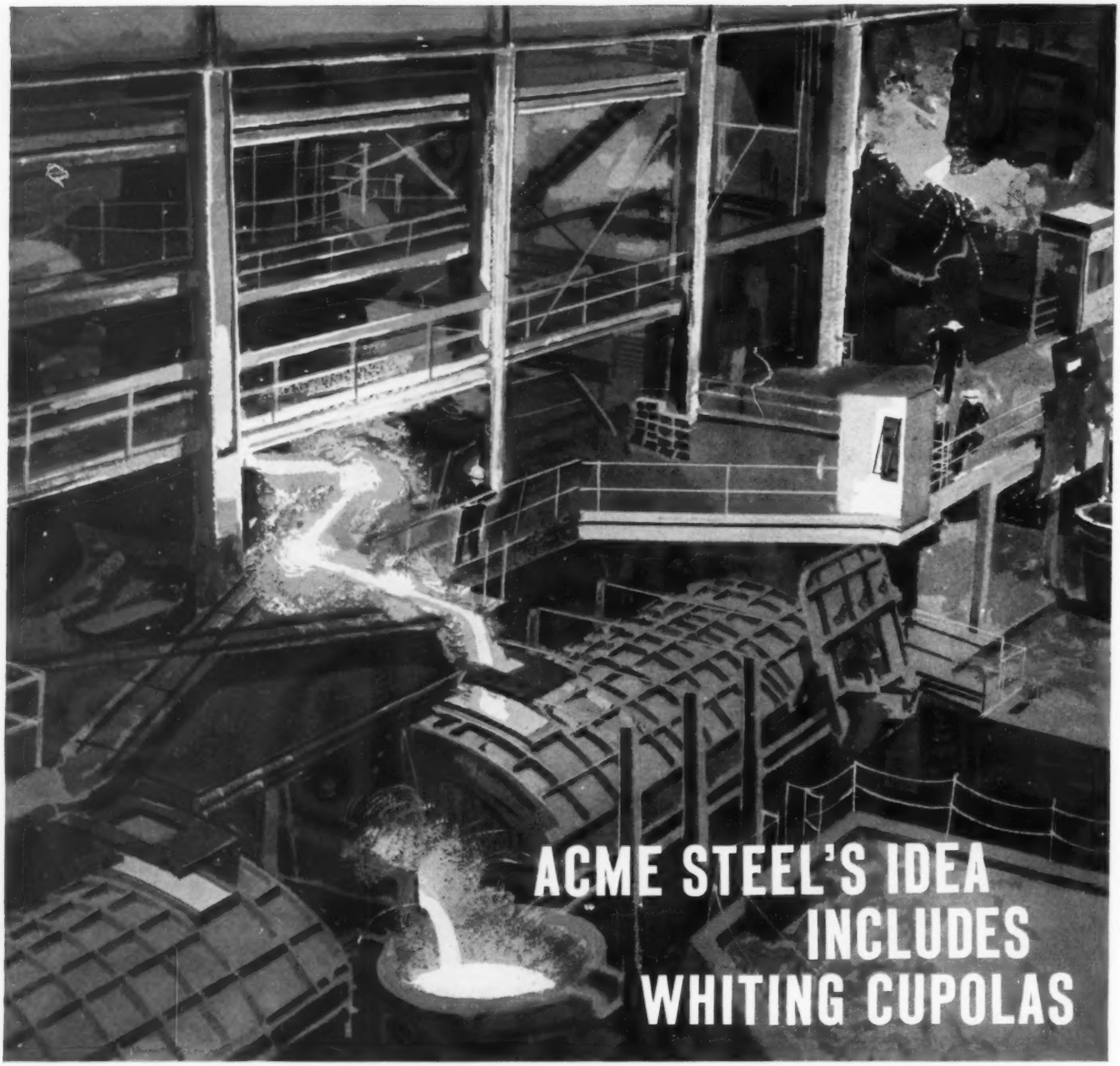

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(*Continued from page 347*)

conference, all the discussions, comments, questions and answers are included. Ninety-seven tables charts, graphs and diagrams are reproduced.

"Case Histories on Statistical Methods for Quality Control," prepared by the Metals Technical Committee of the American Society for Quality Control, is the second in a series. This contribution to the metallurgy of steel is believed to be a unique approach to the study of statistical methods. The common approach is to learn methods in the same manner that they are later to be used, that is the study of data. Their proposal was that much could be learned about the relations existing among methods by using the data to study the method.

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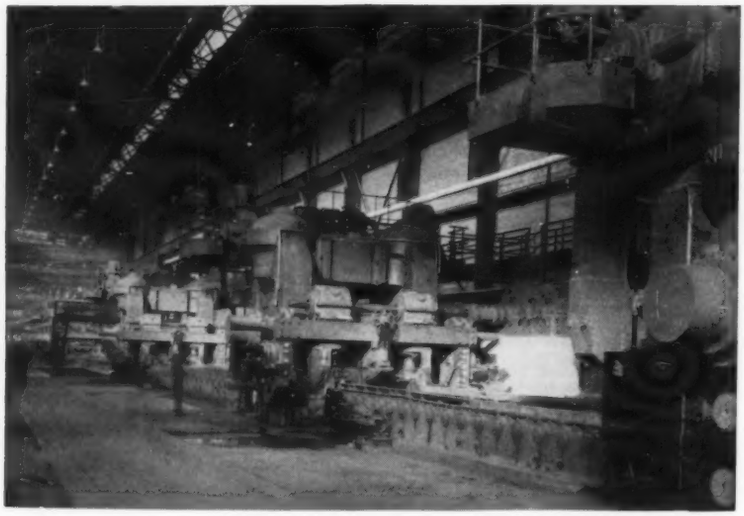

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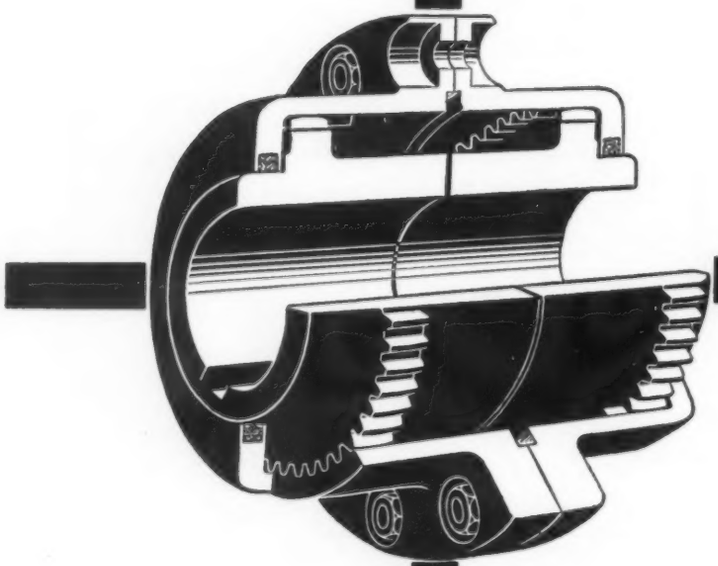

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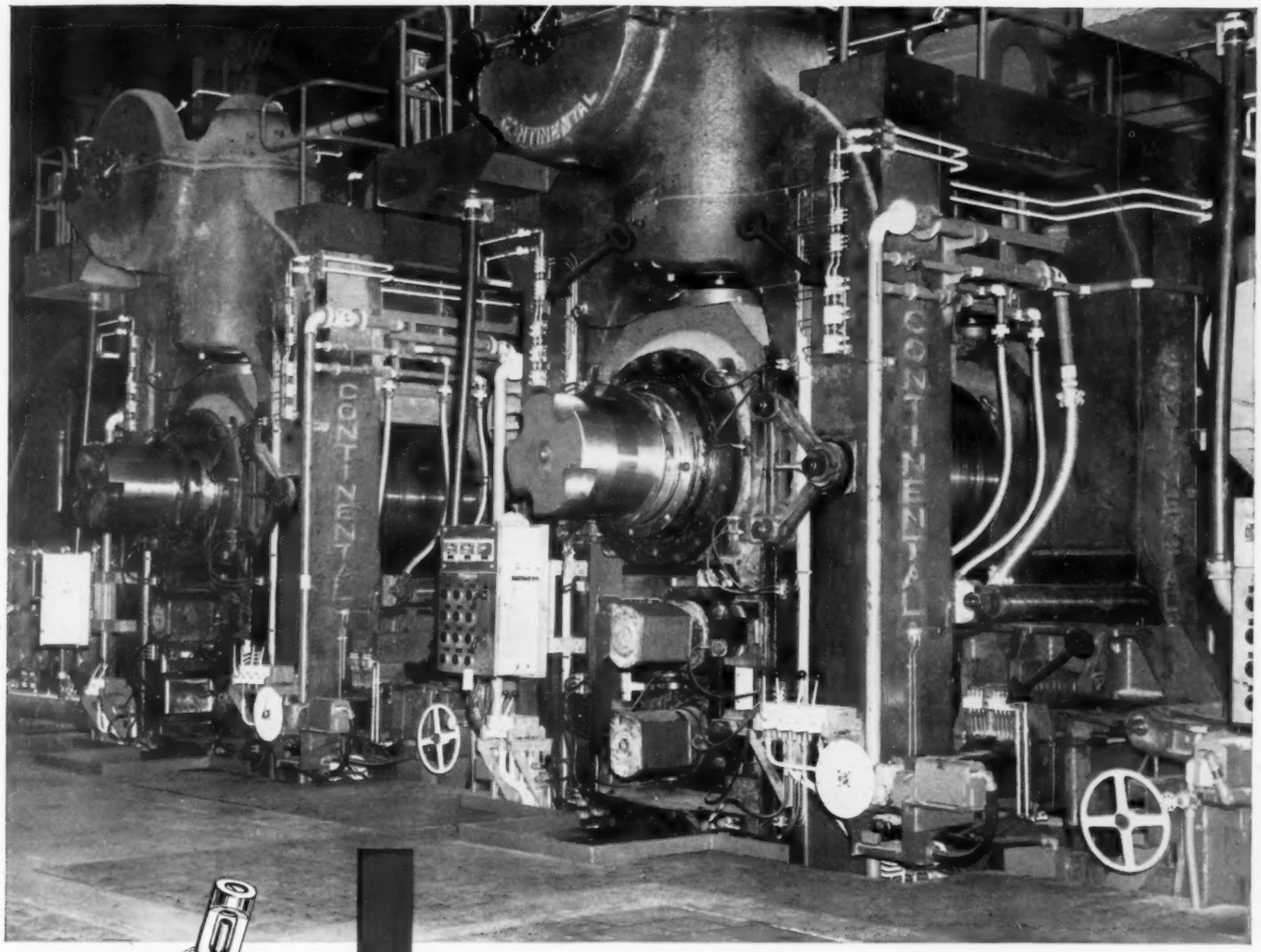

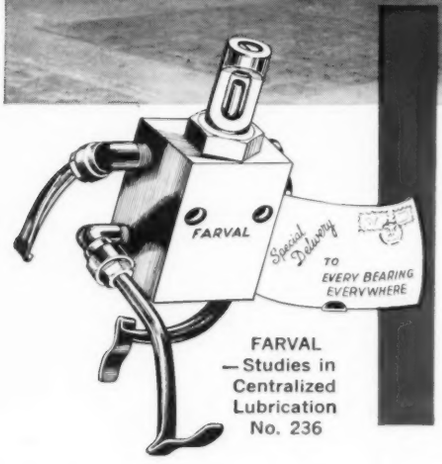

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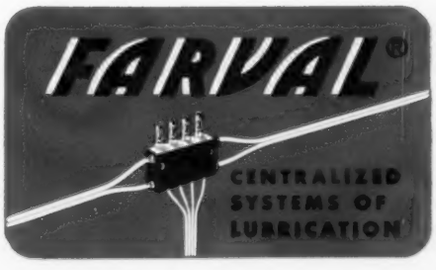

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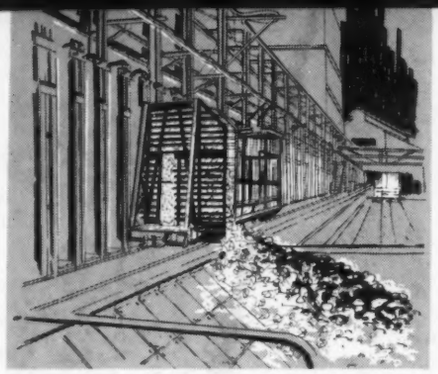

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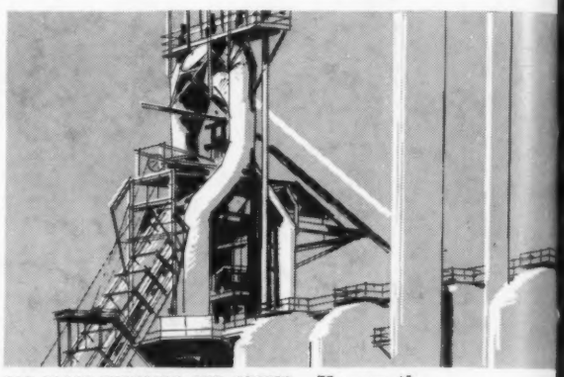
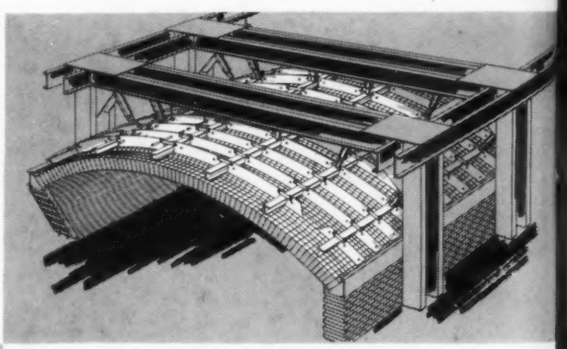
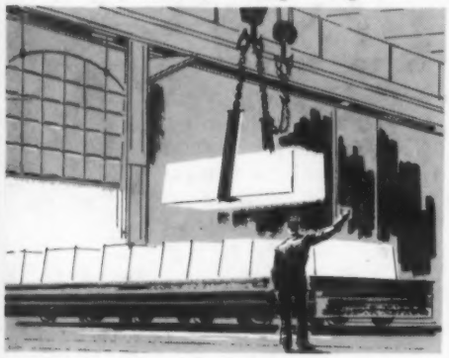


FOR BLAST FURNACES AND STOVES—KAOSIL the unique semi-silica fireclay brick; VARNON BF and H-W 18 brands which have maximum immunity to the effects of carbon monoxide and to other destructive factors; Harbison-Walker castables for monolithic constructions.

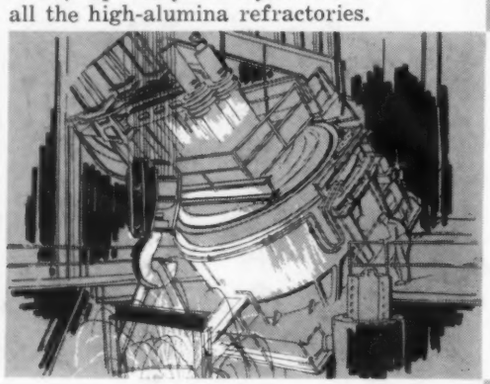


FOR OPEN HEARTH STEEL FURNACES—VEGA the original superduty silica brick and VEGA HP of exceedingly high spalling resistance for hot patching; H-W C-MIX and H-W MAGNAMIX for contour-formed monolithic bottoms; FORSTERITE L regenerator checkers; METALKASE MAGNEX OHR XXP for basic roofs.

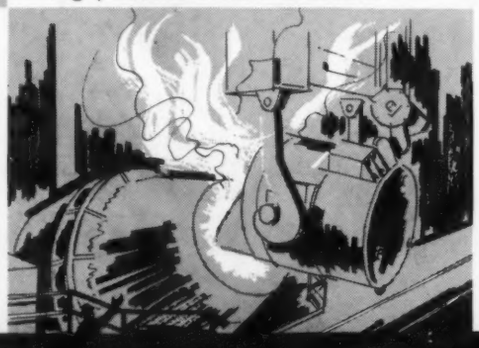
FOR HEATING FURNACES—All classes of high-duty, superduty and high alumina refractories. H-W 23 LI brick—high strength, insulating value and immunity to controlled atmosphere gases.



FOR ELECTRIC FURNACES—All the leading basic brick and monoliths—H-W PERIKLASE; METALKASE; H-W C-MIX; STAR and VEGA silica brick; superduty fireclay brick and all the high-alumina refractories.



FOR OXYGEN VESSELS—OXILINE brands for working linings; OXIBAK for fixed linings; OXIMIX durable monolith.



HW 60-21

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